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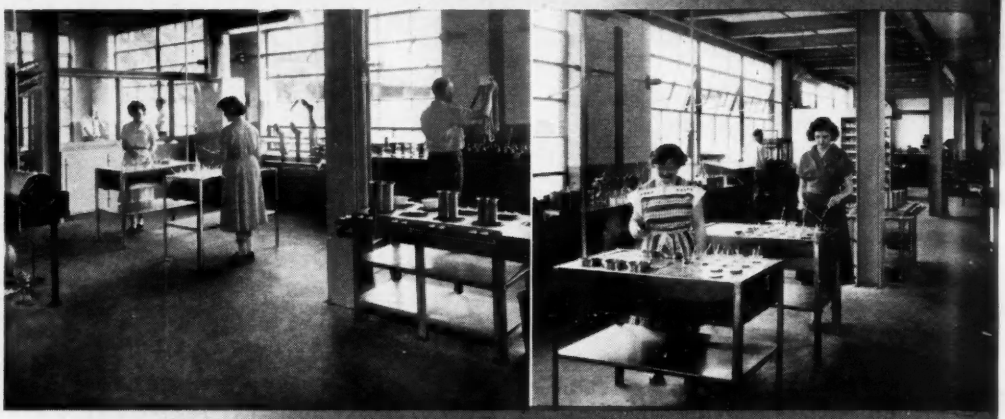

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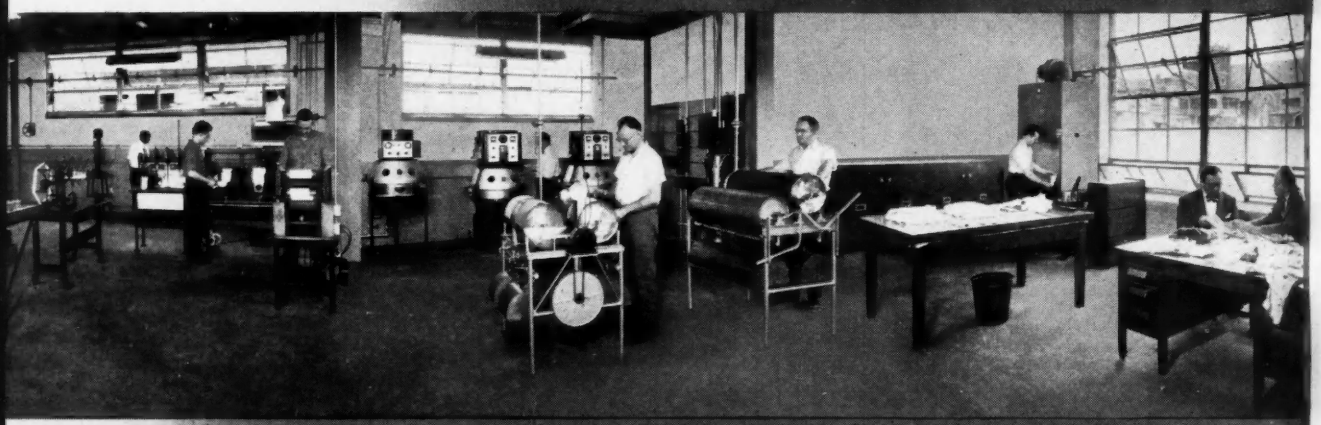

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Proceedings of the
American Association of Textile Chemists and Colorists

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Editor of Proceedings: Carl Z Draves, 30 Lahey St, New Hyde Park, N Y

May 26, 1952

CALENDAR

COUNCIL
June 13 (New York); September 19 (Philadelphia); November 6 (Boston)

GENERAL RESEARCH COMMITTEE
(See Council dates)

NATIONAL CONVENTIONS
November 6-8, 1952 (Hotel Statler, Boston); September 17-19, 1953 (Hotel Conrad Hilton, Chicago); 1954 (Atlanta, Ga).

HUDSON-MOHAWK SECTION
June 20 (Annual Outing).

MID-WEST SECTION
June 14 (Lake Lawn Lodge, Delavan, Wis); October 4 (Hotel Bismarck, Chicago).

NEW YORK SECTION
June 13 (Outing, North Jersey Country Club, Wayne, N J).

NORTHERN NEW ENGLAND SECTION
June 6 (Outing, Merrimack Valley Country Club, Methuen, Mass); December 6 (Annual Meeting, Lowell Textile Institute).

PHILADELPHIA SECTION
June 13 (Outing, Lu Lu Temple Country Club, North Hills, Pa).

PIEDMONT SECTION
June 6-7 (Ocean Forest Hotel, Myrtle Beach, S C); Sept 13 (Hotel Charlotte, Charlotte, N C).

RHODE ISLAND SECTION
June 6 (Outing, Wannamoisett C C); Oct 24 (Providence Engineering Society); December 5 (Annual Meeting, Sheraton-Biltmore, Providence, R I).

SOUTH CENTRAL SECTION
Aug 22-23 (Outing, Chattanooga Golf & Country Club); December 6 (Patten Hotel).

SOUTHEASTERN SECTION
June 6-7 (Outing, Radium Springs, Ga); Sept 13 (Biltmore Hotel, Atlanta).

WESTERN NEW ENGLAND SECTION
June 20 (Outing); Oct 3, Nov 14 and Dec 12 (Rapp's Restaurant, Shelton, Conn).

EMPLOYMENT REGISTER

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Textile Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the Secretary.

HOTEL RESERVATIONS FOR 1952 CONVENTION

(1) Regular hotel reservations will be handled solely through a Convention Housing Bureau. Adequate accommodations will be available. Early in September, each member of the Association shall receive complete information on the subject of hotel reservations, rates, etc, plus a card on which the desired accommodations can be specified.

(2) Members desiring suites or reception rooms should communicate directly with the hotel, since these will not be handled by the Convention Housing Bureau. To obtain these latter accommodations, it is suggested that the following hotels be contacted:

Hotel Statler
Boston 17, Massachusetts

Hotel Bradford
Boston 16, Massachusetts

Sheraton Plaza
Boston 16, Massachusetts

Parker House
Boston 7, Massachusetts

Hotel Touraine
Boston 16, Massachusetts

OTHER EVENTS

AMERICAN CHEMICAL SOCIETY
7th National Chemical Exposition, Sept 9-13, Chicago Coliseum, Chicago, Ill. This will include the 2nd International Art Exhibit.

AMERICAN OIL CHEMISTS SOCIETY
Short Course industrial trips, July 8-9, 10-11.

AMERICAN LEATHER CHEMISTS ASSN
Annual Convention, June 1-4, New Ocean House, Swampscott, Mass.

AMERICAN SOCIETY FOR QUALITY CONTROL
Sixth Annual Convention, May 22-24, Syracuse, New York.

AMERICAN SOCIETY FOR TESTING MATERIALS
Annual Meeting, June 23-27, 1952, New York. N Y. (The biennial Apparatus and Photographic Exhibits will be held in conjunction with this meeting).
1953 Annual Meeting, June 29-July 3, Chalfonte-Haddon Hall, Atlantic City, N J.

AMERICAN STANDARDS ASSOCIATION
3rd National Standardization Conference, Sept 8-10, Museum of Science and Industry, Chicago, Ill.
34th Annual Meeting, November 19, Waldorf-Astoria, New York, N Y.

AMERICAN TEXTILE MACHINERY ASSOCIATION
Exhibit of American Textile Machinery, April 26-May 1, 1954, Atlantic City Exhibition Hall. Atlantic City, N J.

CANADIAN TEXTILE SEMINAR
September 11-13, Queen's University, Kingston, Ont.

CHEMICAL SPECIALTIES MANUFACTURERS ASSOCIATION
38th Midyear Meeting, June 9-10, Sheraton-Plaza Hotel, Boston, Mass.

FIBER SOCIETY
Sept 10-11 (Princeton, N J).

INTERNATIONAL COTTON AND RAYON EXHIBITION
Sept 27-Oct 12, Busto Arsizio, Italy.

INTERNATIONAL ORGANIZATION for STANDARDIZATION
Meeting of Technical Committee 38 (Textiles), Subcommittees 2 (Shrinkage of Fabrics in Washing) and 6 (Fiber Testing)—June 13, 14 and 16, Columbia University, New York, N Y.

LEIPZIG FAIR
September 7-17, Leipzig, Germany.

NATIONAL ASSOCIATION OF HOSIERY MANUFACTURERS
41st Knitting Arts Exhibition, April 27-May 1, 1953, Atlantic City Auditorium, Atlantic City, N J.

NEW YORK BOARD OF TRADE (DCAT)
26th Annual Meeting: September 25-28, Pocono Manor Inn, Pocono Manor, Pa.
27th Annual Drug, Chemical and Allied Trades Dinner, March 5 (1953), Waldorf-Astoria, New York, N Y.

TEXTILE INSTITUTE
Annual Conference, June 2-6, Edinburgh, Scotland.

TEXTILE WORKSHOP
June 16-July 25, Lowell Textile Institute, Lowell, Mass.

Intersectional Contest
First Prize Winner——

MEASUREMENT OF FABRIC SOILING*

NEW YORK SECTION

E A Leonard

COMMITTEE

E W K Schwarz, *Chairman*
Edmund A Leonard, *Secretary and Speaker*
K Barnard
J F Hagen
E Hansen
G Slowinske
R Smith
E I Valko

The history of publications and projects on measurements of fabric soiling is reviewed. From this history the known facts on mechanisms of fabric soiling and soil retention are summarized. Three test methods standardized by the Committee are described and examples of their applications illustrated. The test methods are designed to evaluate in a controlled way the various mechanisms by which soil may impinge upon textiles. The examples used for illustrative purposes demonstrate the importance in soil retention of fabric construction, type of fiber and type of finish.

The busy reader who will not have time to read the whole paper is urged to read the "Summary and Conclusions" near the end for a further synopsis.

Eugene W K Schwarz

INTRODUCTION

IN SPITE of the great fund of literature on textile detergency and its measurement, very little material has been published on the causes and measurement of soiling, from which arises the need for detergent operations. Conventional thought has made the tacit assumption that fibers and fabric have a "natural" tendency to become dirty and that nothing can be done about it—much the line of thinking that prevails in connection with the weather. Consequently, time and money have been expended on attempts to better remove the soil that "naturally" occurs on textile fabrics.

A few imaginative persons have in recent years conceived the hypothesis that perhaps treatments can be applied to improve the natural soiling tendencies of fibers and fabrics and there has already been some research in the area of "soil proofing" or "soil resistance" or "soil retardance". These terms imply distinctions analogous to the differences in meaning among the terms "mothproof", "moth-resistant", and "moth-repellent". The limited amount of published work has not been consistent in terminology or criteria of evaluation, particularly as they may relate to service conditions.

The Committee realizes, however, that awareness of soiling as a separate variable is growing and that investigations aimed at the control of soiling are crystallizing out of the currently amorphous thinking. Furthermore, the Committee is of the opinion that effective research in this, as in all other fields of technical endeavor, must be based on suitable test methods and criteria of performance.

It is therefore the purpose of the Committee in developing this paper to present laboratory test methods by which the soiling tendency of fabrics may be measured. In so doing at an early pioneering stage of knowledge in "soil-proofing", or what have you, the Committee hopes that orientation of thought and aims can be accelerated to the benefit of more rapid progress.

Although some of the treatments evaluated as examples—necessarily included to demonstrate application of the test methods herein described—show a soil-resisting effect, it is not within the scope of this paper to show how *soil-proof* fabrics can be made. The latter step can only result from intensive applied research and commercial development which give thorough consideration to economic values, technical manufacturing problems, and the careful delineation of valid claims. The importance of this point is brought out in the data presented below and is emphasized at the conclusion. Soil resistance that is real as defined by procedures specified below occurred among the tests performed in compiling this paper. Whether such soil resistance is of practical significance remains to be seen, and for this reason caution against broad and general interpretation of the results is recommended.

To further specify the scope of this paper, two additional limitations are noted:

1) Measurement of spotting and staining tendencies by liquids or liquid-borne soils is not covered by the tests described here. Tests for resistance of fabrics to spotting and staining are available and in common use. The present subject matter is concerned solely with the tendency of fabrics to pick up dry pigment-type soils within the range of normal atmospheric conditions.

2) Measurement of detergency subsequent to soiling is not considered. The Committee recognizes the possibility that a fabric difficult to soil might also be difficult to clean. Nevertheless, there are in the literature many extended studies on detergency, and published test methods on soil removal, which are available to the research worker. It was therefore decided that time should not be spent on detergency to the detriment of the primary soiling evaluation.

* Presented for the Committee by E A Leonard at the 30th Annual Convention in New York on October 19, 1951 and also before the New York Section on February 29, 1952 at the Hotel McAlpin, New York, N Y.

SUMMARY OF REFERENCES ON TEXTILE SOILING

R B Smith reviewed the status of work on textile soiling measurements in 1949 and reported *(18)*, "There are few data in the literature on methods of measuring soil concentrations on a fabric except in connection with the preparation of standard soil fabrics to be used in measuring detergency. . . . Such soils almost always contain some dark-colored insoluble material and the extent to which this dark . . . soil is removed by a washing process is usually measured by the change in reflectance of the soiled material during washing. Other analytical tests, such as extraction, chemical evaluation of the soiling material and ash tests, have been applied to washed samples in order to evaluate the amount of soil removed."

Under proper conditions, reflectance changes and the other analytical tests mentioned could be applied to the study of fabric-soiling tendencies. The technique of soil application used for making soil cloth is not suitable in this case, however, because the soils are artificially applied from aqueous or oil media in high concentrations, which bear no known relation to the capacity of the base fabric to absorb soil under service conditions.

Utermohlen & Wallace reported on soil cloth preparation in 1947 *(24)*, covering soils made of shortening with carbon black and black iron oxide. Keying the chemical analysis of iron to the reflectance of the cloth, they determined that reflectance is inversely proportional to the log of the concentration of black pigment on the cloth up to the range of excessively heavy soil concentrations. This makes it possible with certain types of soils to determine the concentrations of soil on fabric from reflectance readings alone.

Reporting in 1949 on the continuation of this work, Utermohlen et al *(23)* concluded that principles of detergency differ for the pigment and oil components of a two-phase soil, and that pigment removal in a given detergent system is not dependent upon the absence or presence, or concentration of, an oil component in the artificial soil. It was pointed out that current theories on solid soil removal need reconsideration. This implies that the mechanism by which solid soils are bound to textiles needs investigation, since the forces of detergent action required to release the particles must be at least equal to the force of binding.

Both of the above papers represent work done at the Institute of Textile Technology, Charlottesville, Virginia. In 1948 the Institute undertook a research project for the U S Department of Agriculture, objectives of which are:

(a) to examine cotton fibers and other textile materials for determining the factors that lead to adhesion of soil;

(b) to evaluate finishes, construction, and other factors with a view toward making cotton fabrics more resistant to soiling and thereby increase their utility;

(c) to develop finishes or methods of treatment which will increase the resistance of cotton fabrics toward soiling;

(d) to develop any test methods and techniques necessary for attainment of the aims above.

Progress has been reported periodically at meetings and in publications as follows:

1) Compton & Hart *(4)* described a test method for soiling chopped cotton fibers with carbon black in water dispersion. They concluded from a series of experiments that adhesion of soil under the conditions mentioned is a function of pitting and roughness on the fiber surface and the particle size of the soil. Sorption was concluded to be an unimportant factor. Pretreatment of the fibers with CMC (sodium carboxymethylcellulose) decreased soil retention. This material has been recently published *(5)*.

2) Compton later reported *(6)* on hydrophilic cotton finishes as they were found to affect soil retention in the wet-soiling test. None was found to be as good as CMC. Further experiments were cited to strengthen the earlier conclusion that soil adhesion is due to occlusion in microscopic pits and crevices rather than by sorption.

3) Utermohlen's simultaneous paper *(22)* reviewed the background of thought on soil-resisting cotton and then described soiling properties of 80-square cotton cloth treated with various finishes. Soiling with pigments in aqueous dispersion, carbon tetrachloride dispersion, and dry soiling were evaluated. Except for stating that in the latter case the cloth was tumbled with dry soil and rubber stoppers in a jar, details of the test method are not given in this paper. A later publication *(2)* supplies these details. Partial acetylation and the application of cationic finishes were found to increase resistance to dry soiling of cotton. Starch was found not to alter dry soiling properties noticeably, while vinyl resins and durable hydrophobic finishes caused the cloth to soil more than the untreated. This covers published work on the USDA project up to the present writing. A brief summary has also been written by Scott *(17)*, who described the practical value of CMC as a soil resisting agent applied in the rinse after washing cottons. This refers particularly to improving soil removal in subsequent laundering after service.

An unpublished project of the Research and Development Laboratories, Philadelphia Quartermaster Depot, deserves mention. Tied in with a project for developing use of fibers other than wool in certain textiles, the Laboratories attempted to organize test methods for laboratory screening of fabrics prior to field testing. All work was done on khaki-dyed cloth, and soiling tendency was one of many performance criteria examined. The project was started in 1948 and shelved without completion in view of more immediate concerns in June 1950. Four test methods, all aimed at measuring pickup of dry pigment soils were used:

(a) Tumbling cloth in an end-over-end cylinder with ball-mill stones and filtered natural dirt removed from vacuum-cleaner bags. This is an adaptation of the tumbler test developed by this Committee.

(b) Rubbing a clean cloth against a piece soiled as in (a) above on the Schiefer Abrader for 25 cycles.

(c) Rubbing clean strips of cloth for 10 cycles against a piece soiled as in (a) above on the Wyzenbeck Abrader.

(d) Picking up soil by repeated impact against a relatively clean surface. This is done by mounting a circular wooden quadrant in such a position that it fits with about 1" clearance around ¼ of the circumference of an ordinary yarn reel. A cloth soiled as in (a) is mounted on the quadrant and folded specimens of clean cloth are mounted on the arms in such a manner that they will strike against the quadrant as the reel revolves. A narrow soiled band is produced by running the reel for 20 minutes at 2500 rpm. A variation of this method is to leave the quadrant uncovered and to alternate strips of clean cloth on the arms of the reel with small semiporous bags containing the soil. By this arrangement, the bag striking the quadrant deposits a small amount of soil on it, and the cloth next striking the quadrant picks up some of this soil.

The project was not pursued to the point of correlating the tests, but a very important result was obtained on selectivity of soil absorption via the following experiment:

1) A complex mixture of soil ingredients *(16)*, such as that used by the General Aniline Laboratories, was analyzed spectrographically. Weight ratios of all the important elements were obtained.

2) This soil was applied to different cloths by the tumbler method.

3) After excess soil was removed, the cloths were ashed and the elements again determined spectrographically.

4) It was found that the elements were present on the cloth in the same ratios as in the original soil, that is, there was no selectivity of absorption by elements or groups of elements.

This indicates that electrostatic effects are not so important as may have hereto been believed and that a simple synthetic soil rather than a complex composition could equally well be used to evaluate soiling properties.

According to the ideas developed by ITT, such a result would have to depend on the various components of a complex soil being of similar particle size, since occlusion of particles in pits and crevices on the surface of the fibers requires that the particles be of such size as to fit in the indentations.

The earliest reference on textile soiling goes back to 1929, when Astrom *(2)* wrote a review of literature on the particle size of smokes and fogs, and their adsorption by cotton and wool fibers.

In 1936 Krueger *(9)* made a microscopic study on the soiling of textile goods with usage. He showed with photomicrographs the contamination of cotton fibers in garments by secretions from sweat glands and hair. It was concluded from experiments with cotton fabrics of various constructions that degree of soilage and resistance to removal depend on the solubility of the skin excretions and the nature of the fabric construction. Open weaves permit dirt to penetrate, which hinders cleaning, while surfaces that are close and even, with a tight layer of starch, are resistant to contamination.

Masland analyzed causes of soil retention on various fibers and reported the following conclusions in 1939 *(13)*:

1) Fiber diameter and cross-sectional outline are factors of prime importance in soil retention.

2) These factors are interdependent. Only when a fiber has a large diameter (above 27 microns) and smooth circular cross section essentially free from indentations and channels, can low soil retention be attained.

3) The origin of the fiber is of no moment, whether synthetic or natural, animal or vegetable, except as origin influences morphology.

An interesting test method is described, which involves ball-milling fiber with ashed vacuum-cleaner dirt and removing excess soil by agitation of the soiled fiber in air. A wash solution is then used to remove the dirt retained after soiling and air agitation; and the dirt particles per unit volume of the wash solution are counted microscopically. From a knowledge of the weight of fiber soiled and the volume of the wash solution, results can be easily converted to the number of soil particles retained per gram of fibers.

Masland's work was slanted toward evaluating the suitability of fibers for use in pile fabrics, particularly carpets. Carpets are exposed to more severe soiling conditions in service than any other textile, and carpet people have long been aware of soiling as an important factor in color changes during service. They have learned that the presence of wool grease, spinning oils, or soaps on carpet fibers, even in small percentages, promotes the adhesion of foot-borne soil.

Leonard reported in 1949 *(11)* on the phenomenon of resoiling, a condition of frequent occurrence wherein a washed carpet soils rapidly to a severe degree shortly after replacement in service. It was determined that, if the detergent used in cleaning leaves an oily or liquid residue on the fibers, dirt particles will stick tenaciously, accumulating soil rapidly. A laboratory test method for checking the soiling properties of detergent residues on carpet was briefly described and illustrated. The procedure involves wetting a small piece of clean, light-colored carpet with the detergent solution to be tested, squeezing to a controlled wet pickup and allowing to dry. The small piece is then inserted into a larger rug and exposed to floor service together with controls as required. A detergent that causes soil adhesion will produce rapid darkening of the piece to which applied, as compared with an untreated control. This test method is fully detailed and illustrated in a later publication *(12)* and is one of the methods used by this Committee.

One other reference has been located in the carpet field: in July 1949 a manufacturer put on the market a cotton rug advertised *(1)* as "soil-resistant". It was claimed that the fabric is treated to shed dirt and dust and need be washed once a season as compared with four or six times for untreated cotton rugs. Further information has not been made available.

Getting back to flat fabric, we find that Henno and Jouhet *(8)* in France suggested a test method for fabric-soiling tendencies, which consists of depositing dust from a controlled air current, shaking off the excess, and measuring reflectance with a photometer.

Snell et al reported *(19)* a conclusion that dirt is retained on fabrics by mechanical and electrostatic forces, and oil bonding. This is the only reference to mention electrostatic forces, while mechanical retention and oil bonding are repeatedly brought out in the literature.

In view of this point, the Committee searched carefully for reliable data on the electrostatic properties of soil and dust particles.

Sachsse reported in 1932 *(15)* on the electrical properties of dust, measuring the charges on clouds of particles. He found that magnitude and sign of charge on a cloud as a whole depends on the method of preparation; and particularly on the influence of friction therein, which could produce charges of either sign and high magnitude. No relation could be established between the sign of the charge and the chemical or physical condition of a cloud.

Thomas states *(20)* that only a fraction of particles are charged.

This information is corroborated in an AEC publication on aerosols *(3)*, which adds that, even where ions are produced to serve as nuclei, the aerosol produced will have many uncharged particles, since particles of opposite sign agglomerate and neutralize each other.

From a practical standpoint, Northrup reported *(14)* that the electrostatic properties of nylon are of great importance with regard to its soiling. Special precautions are required in beaming and weaving to keep dirt away from nylon yarns.

This group of references is not sufficient to give a well-rounded picture of the part that electrostatic forces play in textile soiling. The best conclusions that could be made are probably the following:

1) Most soil particles are uncharged and are not drawn to fabrics by virtue of *their own* electrostatic conditions.

2) Frictional forces and other naturally occurring conditions can probably induce static charges of short duration on many soil particles. If these particles come close to a textile before the charges are dissipated, they may be drawn into direct contact, where mechanical forces and oil bonding can come into play.

3) Uncharged soil particles may be strongly attracted to fabrics that have become charged; e g, nylon in processing.

4) The field requires further investigation.

Tests of antistatic materials have been included in this paper to evaluate practical aspects of electrostatic forces in soiling.

On soiling in general, one other area of knowledge has been found to contain pertinent data, and that is the subject of air filtration. The *Handbook on Aerosols (3)* gives an excellent survey of the properties of suspended particles, the mechanism whereby adhesion to fibers occurs, the effect of fabric structure on filter efficiency, and a brief discussion of electrostatic effects. Suspended particles are defined as those having a diameter less than 50 microns, with the majority of particles suspended in air under average conditions being in the range 0.1 to 10 microns. In this reference, it is first postulated that small particles adhere by van der Waals forces to any surface with which they come in contact. From that point mechanisms are described whereby particles suspended in air impinge on fibrous structures:

1) *Direct interception* of a particle in

an airstream by a fiber. A special case of this mechanism is Stoke's Law deposition, wherein particles large enough to show free gravity settling (over 0.3 microns) settle out onto fiber surfaces.

2) *Inertial effect,* based on the assumption of streamline air flow through the structure, wherein large particles (over 1-2 microns) have sufficient inertia to leave the streamlines bending around a fiber and make contact with it. Increase of velocity favors this mechanism of filtration.

3) *Kinetic diffusion,* which is very effective for particles under 0.1 micron. Such particles exhibit Brownian motion, which greatly increases the probability of impingement on fibers. For particles in this size range, filtration is favored by low velocity.

Balancing these mechanisms to the practical limits of filter operation, we may use the following facts to summarize the situation:

1) Very small particles are effectively removed by diffusion and very large particles by inertia and settling.

2) Particles of intermediate size (range 0.1-1 micron) are most difficult to remove, 0.2 microns being worst. In this range, direct interception is the only effective mechanism, which is necessarily inefficient in a structure having large mesh relative to the particle size. (If it is not already understood, filtration does not depend on a screening or sieving action, because a screen of such mesh and fiber size as to sieve out particles of the size under discussion would require fibers of fineness exceeding those available cheaply today, have very low strength, and offer excessive resistance to air flow.)

3) Smaller fiber diameter favors filtration by inertial effect and direct interception because the stream lines bend more sharply around small fibers and lie closer to their surfaces. The layer of stationary air that lies around all fibers in an airstream is thicker the larger the fiber. It has been demonstrated that fibers 1 micron in diameter show greatly improved filtering of particles 0.2-0.5 microns as compared with common fibers. To get a practical idea of the dimensions in which we are dealing rough equivalents are presented in Table I.

A common observation is reported that filters show lowered effectiveness at high humidity. It is concluded that electrostatic charges are built up in a filter under dry conditions, which polarize uncharged particles and attract them from the airstream. An electrostatic filter is made in Canada by carding resin-treated wool, which generates high field intensities by the friction of air passage. This filter removes large particles with extreme effectiveness and is very effective for particles in the range of 0.2-0.5 microns.

TABLE I
FIBERS AND THEIR EQUIVALENT SIZES

Diameter, Microns	*Denier*	*Fiber*
1	.0166	special Fiberglas
10	1.66	fine apparel rayon
20	6.64	cotton
28	13.	56's wool
32	17.	carpet wool

It is obvious that all the principles of particle adhesion to fibrous structures must apply whether they be filters or woven textiles. The relative importance of the various mechanisms would be expected to differ between filters and textiles, however, because most textiles are not designed to have low resistance to air flow, and the mesh size is not large relative to the fiber or yarn size. To put it another way, most textiles are not designed to have high air permeability, while air filters must have it. This fact immediately increases the importance of direct interception as a factor in impingement of particles on textile fibers and might be expected to show greater retention of small particles. Masland *(13)* corroborates this by estimating retained particles to be in the range of 0.2-4 microns. Compton and Hart *(5)* worked with soils of a particle size of 10-100 microns. They found the 10-micron soil to have the greatest darkening power and to be the most difficult to remove by detergency.

This short history of researches on soiling has brought out the following published conclusions:

1) Dirt particles may be brought in contact with fibers by diffusion or deposition from quiet or slowly moving air, by interception or inertial effects from more rapidly moving air, by direct transfer from another surface, or by electrostatic attraction.

2) Having been brought in contact, particles may adhere to fibers by mechanical forces or occlusion in pits and crevices on fiber surfaces, by "oil" bonding, and possibly by electrical forces.

3) Fine fibers retain soil more readily than coarse fibers.

4) Fibers having uneven cross-sectional contours retain soil more readily than those that have smooth circular contours.

5) Soil particles commonly encountered range in size from 50 microns down, and may be subclassified into overlapping size groups, which correspond to the different mechanisms by which they are brought into contact with fiber structures as shown in Table II.

TABLE II
SOIL-PARTICLE CLASSIFICATION

Size microns	*Contact Mechanism (from airstream)*
<0.1	diffusion
0.1-1	direct interception
>0.3	Stokes' Law deposition
>1	inertial effect

TEST METHODS

The term "textiles" covers a vast range of fabric constructions from sheer curtains, stockings, and laces to heavy canvases, blankets and floor coverings. Yet, from the preceding material, we can imagine soil particles to contact the fibers of any given fabric preferentially by one or more of the mechanisms described. Let us consider a few examples:

1) *Light curtains at an open window:* in a breeze an open fabric would act as an inefficient air filter, and suspended particles make contact by direct interception or inertial effect. Under certain conditions electrostatic forces could be generated on the fabric, which would polarize suspended particles and attract them to the fabric.

2) *Light curtains at a closed window:* diffusion and deposition can act under these conditions. If the curtain hangs over a heated radiator, convection currents will carry suspended particles into proximity with the fibers.

These and several other examples may be illustrated as in Table III.

A group of conclusions are immediately pointed out by this arrangement:

1) Service conditions from an inescapable part of the considerations in estimating the soiling properties of fabrics. It is thus an incomplete question to ask, "What are the soiling properties of Fabric A?"; and the question must be made complete by asking, "What are the soiling properties of Fabric A when exposed to direct transfer?", for instance.

2) The mechanisms of impingement and of retention are separate factors in soiling. They are independent of one another, with the possible exception of electrostatic forces, which can both attract and hold particles to fibers. Generally speaking, however, retention is a function of the fabric, while impingement is a function of the service or test condition. The degree of soiling, as noted above, is a result of both functions.

3) It is more than likely that no single test method can properly balance all of the mechanisms of impingement so as reliably to reproduce service conditions for all kinds of textiles. It is clear from Table III, for instance, that gloves and floor coverings contact soil principally by direct transfer, while curtains and flags contact soil by all other mechanisms except transfer. We can conceive without

TABLE III
MOST PROBABLE SOILING MECHANISMS FOR VARIOUS TEXTILES

Fabric and Conditions	*Mechanism of Impingement*	*Mechanism of Retention*	*Normal Service Time for Soiling*
1) Light curtains at open window	Interception & inertial effect	Occlusion, oil bonding by finishing agents	Few weeks—few months
2) Light curtains at closed window	Diffusion & deposition	Occlusion, oil bonding by finishing agents	Few weeks—few months
3) Suitings	a) sleeves, seat and cuffs—direct transfer	Occlusion	a) Few days
	b) top of shoulders—deposition		b) Few weeks
	c) body—direct interception and diffusion		c) Few weeks
4) Women's Stockings	Interception, direct transfer	Occlusion, oil bonding by skin secretions	Few hours—few days
5) Men's Shirts	a) sleeves, collar and cuffs—direct transfer	a) Occlusion, oil bonding by skin secretions	a) Few hours b) Few days c) Few days
	b) Top of shoulders—deposition	b) Occlusion	
	c) Body—interception or diffusion	c) Occlusion	
6) Carpets & Rugs	Direct transfer, deposition	Occlusion, oil bonding	Few months
7) Working Clothes	Direct transfer, interception	Occlusion, and oil bonding	Few hours—few days
8) Flags	Interception, diffusion, inertial effects	Occlusion	Few weeks—few months
9) Tents	Deposition, direct transfer, interception	Occlusion, oil bonding by fireproof finish if any	Few weeks
10) Gloves	Direct transfer	Occlusion	Few hours—few days

danger of ridicule the evaluation of floor-covering soilage by controlled service test in which people walk over rugs in a conditioned atmosphere with traffic counters, etc; and of soiling curtains and flags by blowing dust into a chamber containing strips of test cloth. Our scientific instincts would rebel, however, at a suggestion to soil flags and curtains by walking on them; or to test floor coverings by hanging them in a dusty chamber with a blower. This is the classic objection to using one test for all items in a group: it will not resemble service conditions for at least some of the items.

Yet, a very objective person might ask, "What matters the manner of impingement, so long as it brings soil uniformly in contact with the fabric, and ranks the soiling of test fabrics in the same order as actual service conditions?". This question represents a valid point in the philosophy of laboratory tests: we are interested in reproducing the *effect* of service conditions rather than the *conditions* themselves. Only in the absence of sufficient information to design test variables for reproducing the *effect* directly do we have recourse to reproducing the *conditions* as a means to this end.

The reply to the question asked is that the various mechanisms of impingement are selective in the particle sizes to which they apply. This has been shown in Table II, and, unless it can be proven that degree of fabric soiling is independent of soil-particle size, a single test method is not justified. The work reported by ITT *(5)* and Masland *(13)* show 10-μ particles to cause greater darkening than 100-μ particles; and retained particles on certain fabrics when exposed to impingement of suspended particles, chiefly by direct interception and inertial effect. Air containing naturally suspended particles is drawn through the test fabrics until they soil to a degree which permits observation of soiling visually or by instruments.

II) *Apparatus:* equipment shall include the following items:

A) A set of cylindrical plastic tubes 16 inches in length, 4¾ inches outside diameter, and ⅛ inches in wall thickness. The tubes shall be mounted horizontally with axes parallel and not more than one foot apart. At least two are required and as many more shall be provided as convenient, because the concentration and nature of suspended particles in air cannot be assumed to be constant with time. Only tests that are made simultaneously, therefore, are strictly comparable.

B) In each tube, a 24-volt dc motor and propeller driven thereby, the leading edge of the propeller blade 7¼ inches from the end of the tube which it faces. The motor and propeller shall be mounted so as to place their common shaft congruently to the longitudinal axis of the tube, and the ends of the propeller blade shall have a clearance of 1/16" from the inside wall of the tube. See Figure 1.

C) A variable-output dc power supply for each motor, such that the propeller may be driven to generate a current of air through the tube varying from 0 to 3600 feet per minute, entering from the direction which the leading edge of the propeller faces.

Items A, B, and C may be conveniently mounted in a single cabinet, as in Figure 2.

D) A Taylor anemometer, for measure-

METHOD 1, BLOWER TEST

I) *Scope:* this test evaluates the comparative soiling rates of air-permeable

NOTE: Arrangements for making blower tests on fabrics may be made with Dr Eugene W K Schwarz, Chairman of the N Y Section Research Advisory Committee, 119 West 63rd St, New York 23, N Y. Arrangements may also be made with Dr Schwarz for construction of a blower.

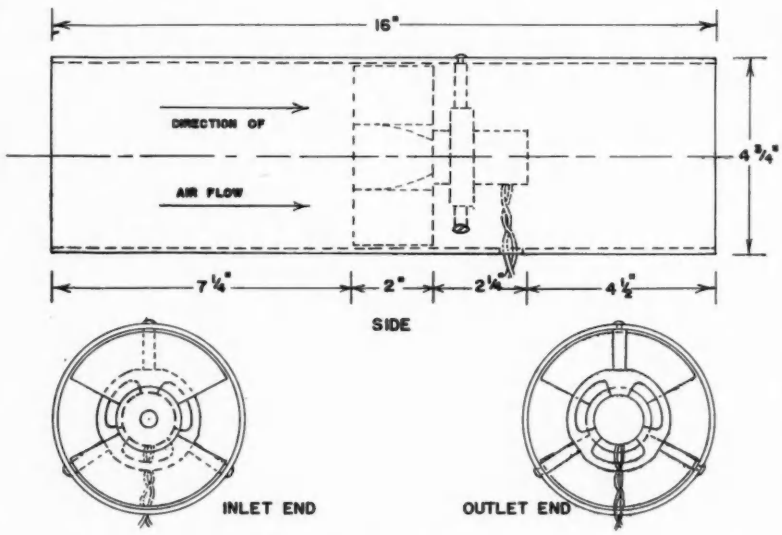

Figure 1
Blower, Propellor & Motor Assembly

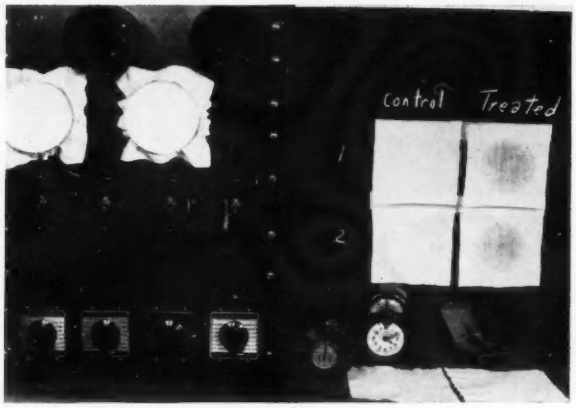

Figure 2
Assembly of Apparatus for Blower Test

ment of air velocity through the tubes.

E) Rubber bands, Atlas Size 32, for fastening test cloths to the inlet ends of the tubes.

F) A Hunter reflectometer.

III) *Test specimens:* since the blower test is relative rather than absolute, it can be used only to compare the soiling properties of fabrics tested simul aneously. At least two test fabrics are required, therefore, but they need have no specific requirements except as follows:

A) Fabrics to be evaluated by the blower test shall have Frazier air permeability of not less than 20 cubic feet per minute per square foot (pressure drop = 0.5 inch H_2O).

B) Test specimen shall be 6" x 6" in size. A sufficient number of specimens shall be tested to minimize the effect of background reflectance in subsequent measurement on the Hunter reflectometer.

C) The control blank for any test whose purpose is to evaluate the contribution to soiling of a treatment or finishing agent shall be put through all the processing steps of the treated test fabric, with the single omission of the finishing agent itself since the blower test is sensitive to small differences in fabric construction. (For instance, if the soiling effect of a cationic softener is under test, the treated test specimen will be prepared by padding in a water solution of the softener, squeezing to a controlled pickup and drying. The control blank shall be prepared in this case by padding in plain water, squeezing to the same wet pickup and drying under the same conditions).

IV) *Procedure*

A) A test specimen shall be fastened with a rubber band across the inlet end of one of the blower tubes.

B) The blower shall be started and the air velocity through the tube shall be adjusted to 440 ± 10 ft/min with the test specimen in place. Velocity measurement shall be made by taking one-minute readings on an anemometer placed at the outlet end of the blower tube.

C) When the test specimens to be compared have all been mounted and adjusted as above, the blowers shall be run for a sufficient time to obtain significant soiling. (The time will vary with the concentration of suspended particles in the air. In an industrial area four hours is a representative test duration.)

D) The blowers shall be shut off and the test specimens removed. Each fabric under test shall be laminated (by running repeat tests as needed) to make a pad containing enough layers to give reliable reflectance readings.

E) The fabric shall then be measured for reflectance with a Hunter reflectometer (other instruments may be applicable).

V) *Analysis & Report*

A) The result for each test fabric shall be reported as the change in reflectance units (ΔR) which occurred as a result of the blower soiling.

B) The soiling properties of test fabrics under comparative evaluation shall be reported as the ratio ($\Delta R_1/\Delta R_2$) of their respective reflectance changes.

C) The soiling properties imparted by a treatment or finishing agent shall be reported as the ratio ($\Delta R_T/\Delta R_B$) of reflectance change for the treated specimens to that of the control blanks, respectively.

Example: a specimen of wool flannel treated with 2% of a cationic softener has an initial reflectance of 51% and a soiled reflectance of 38%. The corresponding control blank has an initial reflectance of 45%.

Then $\Delta R_T = 51 - 38 = 13$,
and $\Delta R_B = 53 - 45 = 8$.
$\Delta R_T/R_B = 13/8 = 1.625$
or, the treated cloth soiled 62.5% more than the blank.

METHOD 2, TUMBLER TEST

I) *Scope:* This test may be used to compare soiling properties of a wide range of fabrics when soil impingement occurs principally by deposition and direct transfer. Test specimens are tumbled in a Launder-Ometer jar with dry pigment soil and steel balls. After removal of excess soil, the results are evaluated optically and by chemical analysis of soil retained on the specimens.

II) *Apparatus:* Equipment and materials shall include the following items:

A) A standard Launder-Ometer, with usual 1-pint Mason jars, and ¼" steel balls.

B) Cylindrical dusting cages, 5 inches in length, 3¼ inches outside diameter, and 1/16 inch in wall thickness. (See Figure 3.) One end shall be fixed and the other end removable. Both ends and cyl-

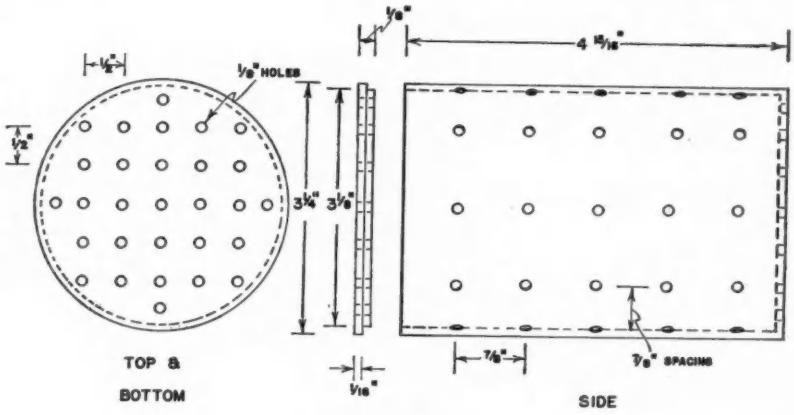

Figure 3
Dusting Cage

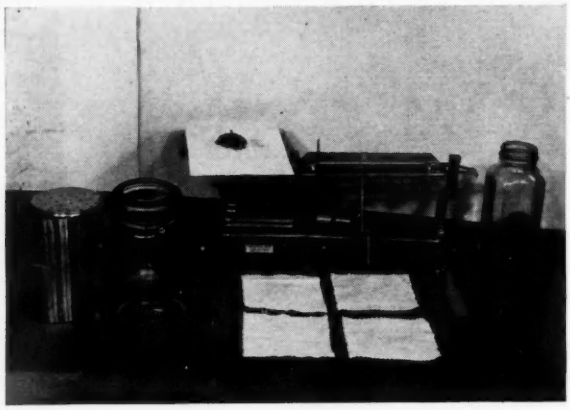

Figure 4
Apparatus and Materials for Tumbler Test

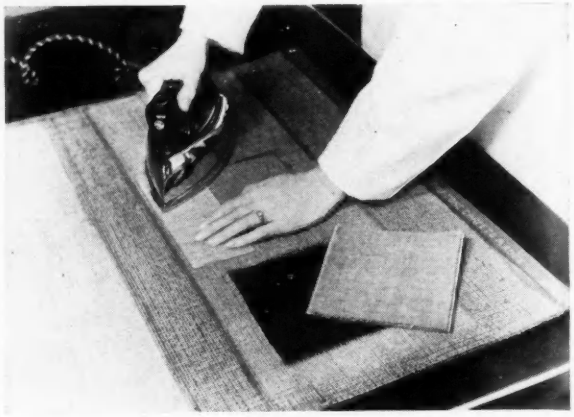

Figure 5
Inserting Test Specimens in Preparation for Floor Soiling Test

inder wall shall be perforated with ⅛" holes 1 inch or less apart. The cages may be made of any convenient material; chrome-plated brass has been tested and found suitable.

C) Dry-pigment soil, consisting of 5 parts powdered bone charcoal (Eimer & Amend) and 50 parts powdered calcined sodium sulfate. A homogeneous powder shall be made by grinding the ingredients together with a mortar and pestle.

D) A Hunter reflectometer.

E) Soxhlet extractors with extraction thimbles.

F) $BaCl_2$ reagent, tetrahydroxyquinone indicator, burets and miscellaneous equipment for analysis of sulfate ion by titration.

III) *Test specimens:* Almost any fabric, from light apparel cloth to heavy floor covering, is applicable to this test. Since soil conditions are not subject to uncontrolled variables as in the blower test, fabrics being compared need not be run simultaneously.

A) Test specimens shall be not less than 3" x 3" in size. A sufficient number shall be run to minimize the effect of background reflectance in subsequent measurement on the Hunter reflectometer.

B) A control blank prepared as described in Method 1, Section III C, shall be used as the basis of comparison in any test whose purpose is to evaluate the contribution to soiling of a treatment or finish.

IV) *Procedure:*

A) A clean, dry, 1-pint Mason jar shall be charged with the following materials (see Figure 4):

1) Two to six test specimens, each 3" x 3", if the weight of the fabric is less than about 12 oz per square yard. For fabrics in excess of that weight, the number of specimens per jar shall not exceed 3. The specimens may represent any group of fabrics being compared, or a group of materials with finishes and their control blanks.

2) 50 ¼-inch steel balls.

3) 5 grams dry soil.

B) The loaded jar shall be mounted in a Launder-Ometer and run for 15 minutes at 42 rpm.

C) The jar shall be removed and the test specimens transferred after gentle shaking to a dusting cage with 50 clean ¼" steel balls.

D) The loaded dusting cage shall be mounted in the Launder-Ometer and run for 15 minutes to remove excess soil.

E) The test specimens shall be removed. Each fabric under test shall be laminated (by running repeat tests as needed) to make a pad containing enough layers for reliable reflectance readings.

F) The specimens will then be measured for reflectance with a Hunter reflectometer (other instruments may be applicable).

G) Each test specimen shall then be analyzed for weight pickup of soil by direct titration of sulfate content as follows:

1) Sulfates may be titrated directly with $BaCl_2$ solution with THQ as indicator, the end point being a color change from yellow to reddish orange.

Principle: As $BaCl_2$ is added to a solution containing SO_4 ions the SO_4 is precipitated as $BaSO_4$, leaving no free Ba ions until all the SO_4 has been precipitated. The Ba salt of the indicator is a reddish orange, and this color forms as soon as there is free Ba ion in solution.

2) Cloth sample shall be brought to constant weight and should weigh at least one gram.

3) Sample shall be extracted 5 times for approximately 45 minutes in a Soxhlet apparatus with a total of 75-85 ml of distilled H_2O. The extract shall be filtered into a 100-ml flask and brought to volume.

4) A 20-ml aliquot shall be used for titration, 30 ml ethyl alcohol 95% shall be added and the pH adjusted to 4-5 with either 0.02N HCl or NaOH.

5) Two (2) drops of 1% THQ solution* (tetrahydroxyquinone) shall be added as indicator, and the solution titrated to reddish-orange end point with 0.05M $BaCl_2$.

V) *Analysis and Report*

A) *Reflectance Analysis:*

1) The result for each test fabric shall be reported as the change in reflectance units (ΔR) which occurred as a result of the tumbler soiling.

2) The soiling properties of test fabrics under comparative evaluation shall be reported as the ratio ($\Delta R_1/\Delta R_2$) of their respective reflectance changes.

3) The soiling properties imparted by a treatment or finishing agent shall be reported as the ratio ($\Delta R_T/\Delta R_B$) of reflectance change for the treated specimens to that of the control blank, respectively.

B) *Soil Pickup by Weight:*

1) The result for each test fabric shall be reported as the percent weight pickup of soil (P) which occurred as a result of the tumbling.

2) The soiling properties of test fabrics under comparative evaluation shall be reported as the ratio (P_1/P_2) of their respective pickups.

3) The soiling properties imparted by a treatment or finishing agent shall be reported as the ratio (P_T/P_B) of pickup for the treated specimens to that of the control blanks, respectively.

Example: a specimen of nylon cloth treated with an antistatic agent weighed 2.223 grams when brought to constant weight, and 1.65 ml of 0.05 M $BaCl_2$ was

* THQ (crystals or 1% solution in tubules) and 0.05 M $BaCl_2$ may be obtained from Smith, New York Laboratories, Freeport, N Y.

used to titrate a 20 ml aliquot. The control blank weighed 2.162 grams and 1.07 ml was used to titrate the aliquot.

$$\text{Then } P_T = \frac{1.65 \times 5 \times .0071 \times 100 \times 55}{2.223 \times 50} = 2.88\%$$

$$\text{and } P_B = \frac{1.07 \times 5 \times .0071 \times 100 \times 55}{2.162 \times 50} = 1.93\%$$

$P_T/P_B = 2.88/1.93 = 1.49$
or, the treated cloth soiled 49% more than the blank.
In general, $P = V/W \times 3.9$
where V = ml used to titrate and
W = weight of sample in grams.

METHOD 3. FLOOR SOILING

I) *Scope:* this test may be used to compare the soiling properties of fabrics normally exposed to direct transfer and deposition. It is especially suitable for floor coverings. Test specimens are inserted into a small rug and exposed to foot traffic until they soil to a degree that permits observation of soiling visually or by instruments.

II) *Apparatus:* the following items shall be included:

A) One or more small rugs, 18" x 27" or 27" x 54". The rugs shall be perforated by holes 6" square and three to 12" apart.

B) Thermoplastic tape for fastening test specimens into the holes of the small rugs (Industrial Tape Corporation, "Permacel" Industrial Tape).

C) Any hand iron in good condition.

D) Vacuum cleaner in good condition, preferably upright type with beater bar or brush.

E) A Hunter reflectometer.

III) *Test specimens:* since the floor-soiling test is relative rather than absolute, it can be used only to compare the soiling properties of fabrics. Since the soiling conditions will vary with time, all the fabrics that are to be compared must be tested simultaneously. Beyond this requirement, the specimens need only meet the following conditions:

A) Test specimens shall be 6" x 6" in size.

B) In any test whose purpose is to evaluate the contribution to soiling of a treatment or finish, a control blank shall be prepared as described in Method 1, Section III C, and used as a basis of comparison.

C) Since this test is sensitive to retention by oil bonding, fabrics to be tested for soiling properties as a function of fabric composition or construction shall be as free as possible from foreign matter, such as oils, waxes, etc.

IV) *Procedure:*

A) Test specimens of the fabrics under evaluation shall be inserted into the holes of the small rugs and fastened in place by ironing across the edges with thermoplastic tape (see Figure 5).

B) When all the test specimens have been inserted and ironed, the assembled exposure panel (see Figure 6) shall be placed in a traffic area where it will be walked on continuously.

C) Once each day the panel shall be vacuum-cleaned and turned so that the traffic is evenly distributed on all parts of the panel.

D) The panel shall be kept in service for a sufficient time to obtain significant soiling (the time will vary with location. In an industrial area 5 to 20 days represent an average test duration. See Figure 7).

E) The panel shall be removed from service, the 6" x 6" specimens taken out and measured for reflectance with the Hunter reflectometer (other instruments may be applicable).

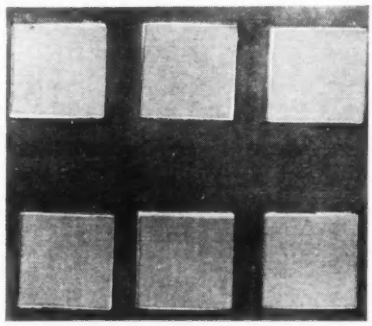

Figure 6
Exposure Panel for Floor Soiling Test

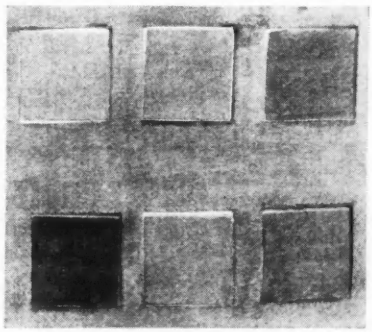

Figure 7
Floor Soiling Test Panel After Service

V) *Analysis and Report*

A) The result for each test fabric shall be reported as the change in reflectance units (ΔR) which occurred as a result of the floor soiling.

B) The soiling properties of test fabrics under comparative evaluation shall be reported as the ratio ($\Delta R_1/\Delta R_2$) of their respective reflectance changes.

C) The soiling properties imparted by a treatment or finishing agent shall be reported as the ratio ($\Delta R_T/\Delta R_B$) of reflectance change for the treated specimens to that of the control blanks, respectively.

Experiments performed as part of the Committee's work in developing the above test methods to their specified state are described in Appendix 1.

We shall now proceed to describe a series of examples, which illustrate the application of Methods 1, 2, and 3.

EXPERIMENTS

Each of the experiments described below was designed to answer a specific question or to test a certain principle. The first group, marked with the prefix "B", is concerned with the blower test; the second group, marked "T", with the tumbler test; and the third, marked "F", with the floor-soiling test. Following these are experiments, correspondingly coded, which concern evaluations made by more than one test method.

Seven flat fabrics and five pile fabrics were used for the experiments. Their constructions are detailed in Appendix 2. The flat fabrics were used for experiments on the blower and tumbler tests, and the pile fabrics were used for tumbler and floor testing.

A) *Blower Tests*

1) Experiment B1

a) *description:* the seven flat fabrics described in Appendix 2 were exposed to the blower test at constant input voltage to the power supplies. The fabric specimens were free of all foreign matter, oils, finishes, etc.

b) *purpose:* to determine gross soiling differences among fabrics made of various fibers and constructions, without separating the effects of the many variables involved.

c) *procedure:* standard blower test procedure as specified in Part III, Method 1, except for adjustment of power-supply input voltage to 110 volts instead of making air velocity constant at 440 ft per min. Exposure time 2 hours.

d) *results:* see Figure 8. The symbols used to code the data have the following meaning:

V = total volume of air in cubic feet which went through the test specimen;

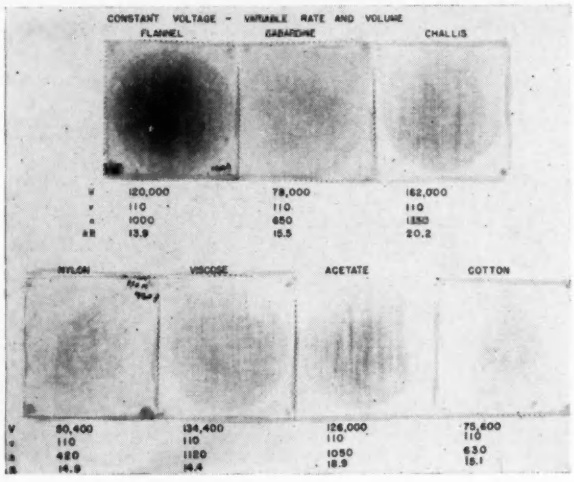

Figure 8
Results of Experiment B_1

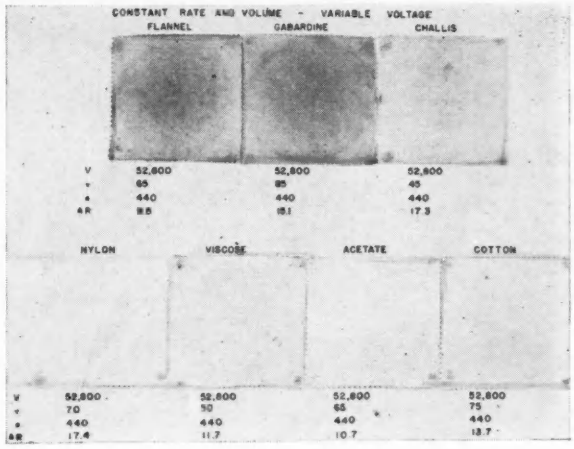

Figure 9
Results of Experiment B_2

v = input voltage to the power supply during test

r = air velocity in feet per minute through the blower tube during test;

ΔR = change in reflectance, always a lowering, of the test specimen as a result of the test.

Because of practical photographic limitations, small reflectance differences often do not reproduce well in prints. This may cause the appearance of test specimens in a photograph to disagree with the ΔR data. In looking at a photograph, therefore, it is more reliable to rank the materials based on ΔR data than their relative appearances in the picture.

All flat-fabric specimens were read at two thicknesses with a black background of reflectance of 4.2%, and pile-fabric specimens were read at one thickness. A series of measurements was made comparing the readings at 1, 2 and 4 thicknesses for all 7 flat fabrics. Significant differences were found only between readings at one and two thicknesses. The maximum differences between two and four thicknesses was 1.4% (gabardine) and the minimum 0. The level of reflectance in which these data were taken runs from 32.5 to 41.6%. To a certain extent the reflectance value has only a relative effect, and as long as a constant procedure is used a series of data will be consistent within tests. One cannot, however, expect agreement with some other system of reading and reporting reflectance data. Further discussion of this point occurs in the Summary.

e) *conclusions:*

(1) fabrics vary widely in extent of soilage.

(2) because of different air permeabilities, fabrics cause unequal air velocities in the blower tubes at constant input voltage. Thus, fabrics with greater air permeability permit of high velocities and filter a greater volume of air in a given time.

(3) because of other variables, such as construction, air volume, and velocity, no conclusion can be made from this experiment about the soiling properties of different fibers.

(4) because the three woolen fabrics show different soiling properties with type of fiber constant, fabric construction is concluded to be an important factor in soiling by the mechanisms which act in this test.

2) *Experiment B2*

a) *description:* similar to B1, except for use of constant air velocity instead of constant input voltage.

b) *purpose:* to determine gross soiling differences among fabrics made of various fibers and constructions, when air velocity, and therefore total air volume, is constant.

c) *procedure:* standard blower test procedure, with air velocity at 440 ft per min. Exposure time, 2 hours.

d) *results:* See Figure 9. The fabrics still exhibit large differences in soilage, but do not rank in the same way as in B1.

e) *conclusions:*

(1) fabrics made of different fibers and construction exhibit unequal soilage when used to filter out a given quantity of air at a fixed mean air velocity through the fabrics.

(2) it is commonly stated that certain types of fibers tend to soil more readily than others. The 7 fabrics tested here are representative constructions of 5 different fibers. The amount of soiling shown by the three wool fabrics covers the entire range of soiling exhibited by the fabrics made from the other fibers. This demonstrates that, by blower test, construction is a more important factor in soiling than the nature of the fiber from which the fabrics are made.

3) *Experiment B3*

a) *description:* wool flannel and acetate cloths were exposed to the blower test at varying air velocity, and constant total volume of air.

b) *purpose:* to determine effect of air velocity on soilage in the blower test.

c) *procedure:* standard procedure for blower test, except air velocity was varied from 100 to 1000 ft per minute, and exposure time was adjusted to keep total air volume constant (48,000 cu ft) on all specimens.

d) *results:* see Figures 10, 11, 12. Increasing air velocity clearly increases soilage. In addition to the samples shown, other woolens, viscose, nylon, and cotton fabrics were tested with the similar result that the effect is independent of fiber type.

e) *conclusions:* the results corroborate the statement in reference *(3)* that increased air velocity favors impingement of air-borne particles by inertial effect.

f) *discussion:* in Experiment B1, those fabrics which showed greatest velocity at fixed input voltage showed greatest soiling. This result is now understood to be a result of both larger air volume and higher velocity. In Experiment B2 the tube velocities are the same, but in the less permeable cloths higher voltage is required to pull air through at 440 ft per minute. In such cases the velocity through the pores themselves

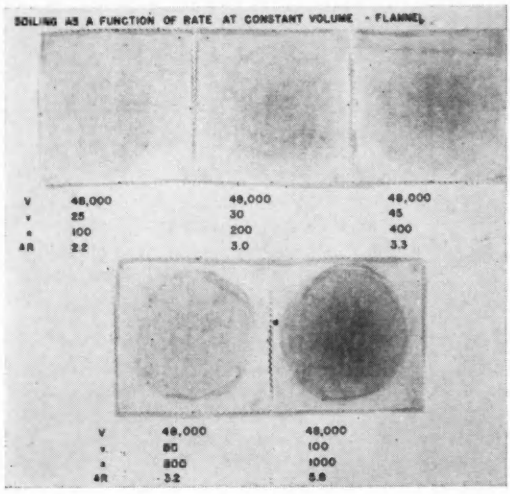

Figure 10
Results of Experiment B_3

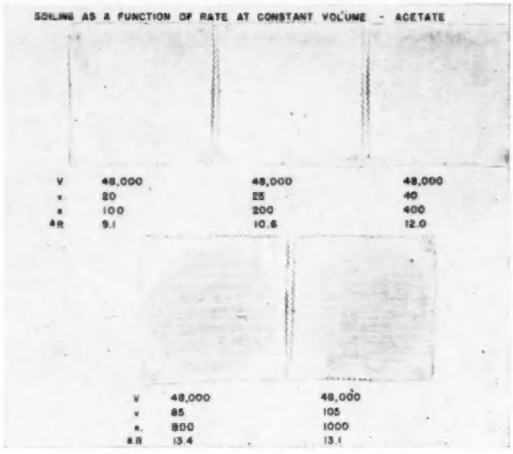

Figure 11
Results of Experiment B_3

must be greater. If no factor in construction other than pore size affects soiling, one would expect the least permeable cloths to soil most, other things being equal. No such consistency appears in the results of B2, however, even among the three woolen fabrics, and it must again be concluded that other construction differences mask the expected result, such as the complete geometry of the pore system. The following experiment was suggested for a check of this hypothesis.

4) *Experiment B4*

a) *description:* 80-square cotton cloth was subjected to the blower test in original condition and after water shrinkage to reduce pore size.

b) *purpose:* to determine the effect of pore size on soiling, other things being equal.

c) *procedure:*

(1) a specimen of 80 x 80 cloth was wet out and dried on a frame to prevent shrinkage. Another was wet out and allowed to shrink in drying.

(2) both specimens were photomicrographed and pore sizes estimated by measurement on a print of known enlargement.

(3) the specimens were exposed to the blower test at 440 ft/min for 8 hours.

(4) air velocities through the pores were calculated and reflectances measured.

(5) another pair of specimens was run by adjusting air velocity *through the pores* constant for both. Total volume was constant.

d) *results:* (1) See Table IV

(2) Thus, shrinkage halved the pore size (See Figure 13), tripled air velocity through the pores at constant tube velocity, and doubled the soiling.

(3) Conversely, the second pair of specimens in which pore velocities were made constant showed nearly the same degree of soiling. The difference of 10% may be due to the poor precision of pore-size measurement, or a change in

TABLE IV
BLOWER SOILING AS A FUNCTION OF PORE SIZE

Specimen	*Counts*	*Frasier Air Perm cu ft/min/sq ft*	*Avg Pore Size inches*	*Tube Vel ft/min*	*Pore Vel ft/min*	$\frac{\Delta R_T}{\Delta R_B}$ %
1) Unshrunk	80x87	99.0	0.004	440	3256	200
Shrunk	82x89	74.4	0.002	440	9856	
2) Unshrunk	80x87	99.0	0.004	1300	9900	110
Shrunk	82x89	74.4	0.002	440	9900	

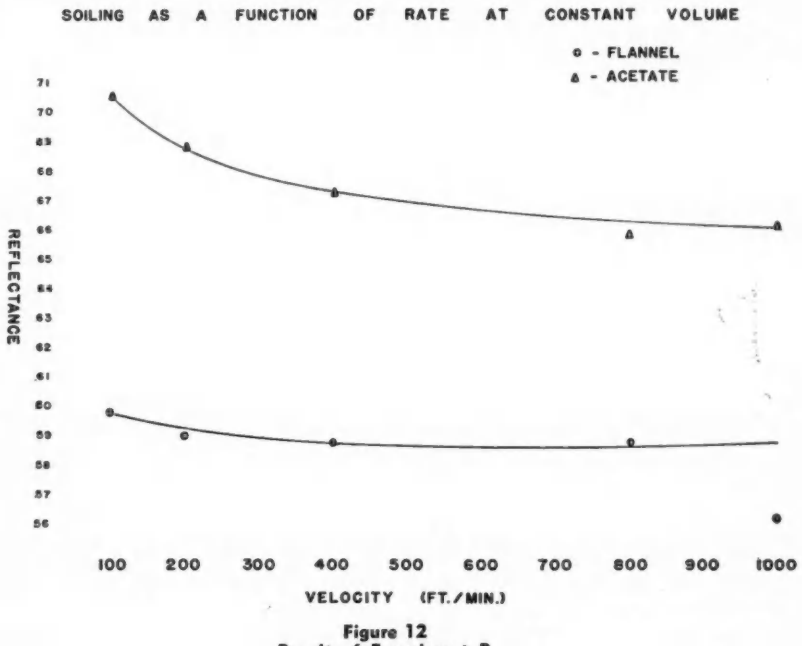

Figure 12
Result of Experiment B_3

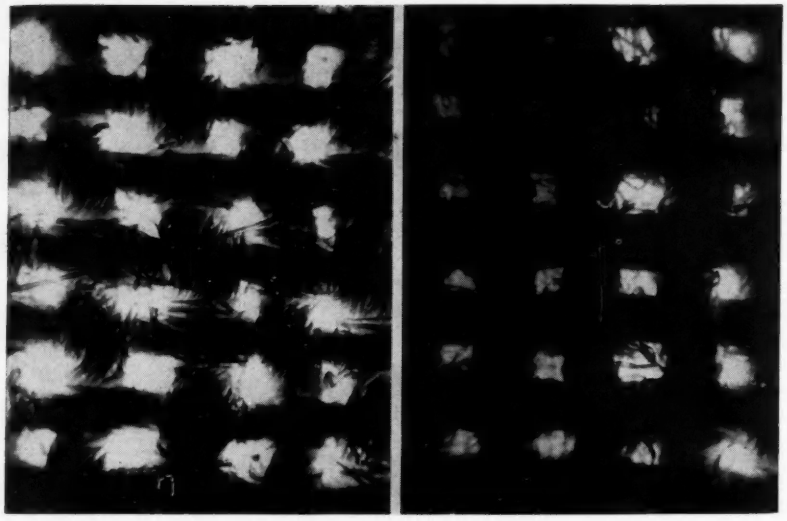

Figure 13
Results of Experiment B_1

pore geometry.

e) *conclusion:* for a given gross air velocity through a fabric, pore size is a factor in soiling. Smaller pore size favors soiling.

B) *Tumbler Tests*

1) *Experiment T1*

a) *description:* the 7 flat fabrics were exposed to the tumbler test. The specimens were free of all foreign matter, oils, finishes, etc.

b) *purpose:* to determine soiling differences among fabrics made of various fibers and constructions.

c) *procedure:* standard procedure as specified in Part III, Method 2.

d) *results:*

TABLE V

Fabric	*ΔR*	*P*
Gabardine	28.8	1.25
Flannel	29.3	1.6
Challis	21.7	0.85
Nylon	27.0	0.86
Cotton	34.8	0.96
Acetate	33.9	1.04
Viscose	37.2	1.36

e) *conclusions:*

(1) the fabrics show varying degrees of soiling. It can be said in general that the viscose, acetate and cotton fabrics soiled more than wool and nylon fabrics. Since, however, the fabrics are different in construction, the effect of fiber type on soiling, if any, cannot be isolated.

(2) this test may be less subject to construction differences than the blower test because, in Experiments B1 and B2, the three woolen cloths covered the entire soiling range, while, in this experiment, they are grouped closer together.

2) *Experiment T2*

a) *description:* the 5 pile fabrics without treatment and essentially free of all oils, finishes and foreign matter were exposed to the tumbler test.

b) *purpose:* to determine soiling differences where fabric constructions are essentially the same.

c) *procedure:* standard tumbler test.

d) *results* are shown in Table VI.

TABLE VI

Carpet Type	*ΔR*	*P*
Wool	17.5	3.5
Nylon	32.1	3.64
Cotton	31.6	1.95
Acetate	37.9	2.34
Viscose	46.7	3.08

e) *conclusions:*

(1) the wool fabric resisted soiling most with nylon, acetate, and viscose soiling more in that order. The backing construction of the cotton fabric was not identical with that of the other fabrics. In that respect, therefore, the construction may have played a part in the value noted for the cotton specimen.

(2) except for cotton, Experiments T1 and T2 rank the five fibers with respect to soiling in the same way even though the fabric in the two experiments differed in construction and in fiber size.

C) *Floor Soiling Tests*

1) Experiment F1

a) *description:* the 5 pile fabrics described in Appendix 2 were subjected to floor soiling. The specimens were untreated and free from oils, finishes, and foreign matter.

b) *purpose:* to evaluate the soiling differences of pile fabrics having essentially identical construction, and thus to determine the soiling differences arising from the fibers of which they are made.

c) *procedure:* standard floor-soiling test procedure as specified in Part III,

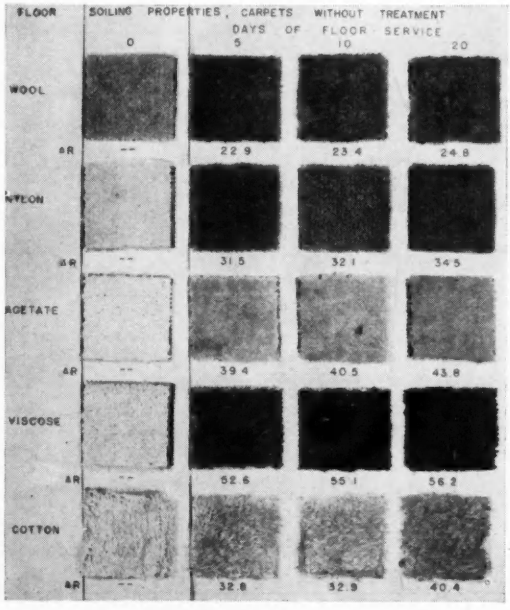

Figure 14
Experiment F_1

Method 3. Exposure times of 5, 10 and 20 days were used.

d) *results:* See Figure 14.

e) *conclusions:*

(1) the wool fabric showed least tendency to soil with nylon, cotton, acetate and viscose soiling increasingly in that order.

(2) these results are close to those of tumbler experiment T2 above, but bear no relation to the results of the flat fabrics on the blower test.

D) *Flat Fabrics with Various Treatments and Finishes Tested on Both Blower and Tumbler Tests*

1) Experiment BT1

a) *description:* the 7 flat fabrics were given various treatments and finishes and tested for comparison of soiling properties between the untreated and treated.

b) *purpose:* to compare the sensitivities of blower and tumbler tests toward the effect of soiling properties of representative treatments and finishes applied to flat fabrics.

c) *procedure:* standard procedure for blower and tumbler tests.

d) *results:* See Tables VII through XIII and Figure 15.

e) *conclusions:*

(1) Wool Fabric

(a) melamine-formaldehyde treatments showed soil resistance on 8 out of 9 measurements made. On the 9th no soiling difference was found as compared with the untreated fabric. The extent of soiling resistance varied with the test method.

(b) The preponderance of data for all the other treatments (oils and waxes) indicate increased soiling. This supports the references on soil retention by oil bonding.

TABLE VII
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
WOOL GABARDINE

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ *Blower*	$\frac{\Delta R_T}{\Delta R_B}$ *Tumbler*	$\frac{P_T}{P_B}$ *Tumbler*
Melamine Formaldehyde	57%	86%	49%
Peanut Oil	76	153	331
Lard Oil	123	121	263
Wax Repellent	161	135	114
Sulfonated Mineral Oil	164	138	166

TABLE VIII
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
WOOL FLANNEL

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ *Blower*	$\frac{\Delta R_T}{\Delta R_B}$ *Tumbler*	$\frac{P_T}{P_B}$ *Tumbler*
Melamine Formaldehyde	66%	96%	42%
Peanut Oil	135	90*	365*
Lard Oil	150	165	564
Wax Repellent	176	61*	88*
Sulfonated Mineral Oil	115	114	265

* Specimens folded in Tumbling

TABLE IX
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
WOOL CHALLIS

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ *Blower*	$\frac{\Delta R_T}{\Delta R_B}$ *Tumbler*	$\frac{P_T}{P_B}$ *Tumbler*
Melamine Formaldehyde	90%	100%	93%
Peanut Oil	310	115	416
Lard Oil	289	147	277
Sulfonated Mineral Oil	180	124	303

TABLE X
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
NYLON

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ *Blower*	$\frac{\Delta R_T}{\Delta R_B}$ *Tumbler*	$\frac{P_T}{P_B}$ *Tumbler*
Antistatic	87%	144%	73%
Antislip	150	147	168

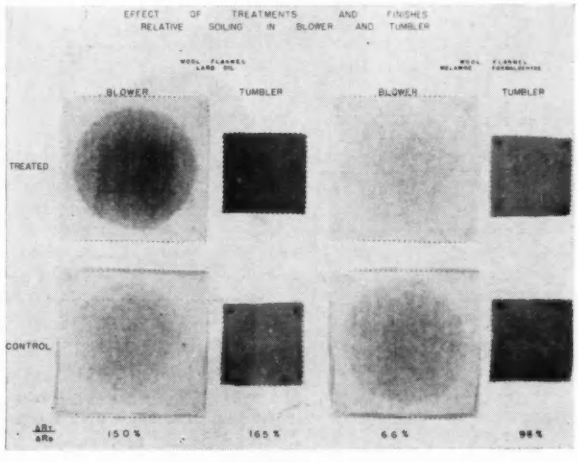

Figure 15
Representative Results From Experiment BT$_1$

(2) Cotton Fabric:

(a) The melamine-formaldehyde and combined water-repellent and resin-finished specimens showed soil resistance by both test methods.

(b) The wax-repellent finish showed increased soiling by both test methods as one would expect from oil bonding.

(c) A semidurable water-repellent finish showed either soil resistance or no increased soiling on both tests.

(d) The other treatments showed no correlation between the results of the two test methods.

(3) Nylon Fabric:

(a) The antislip agent indicated increased soiling, probably due to oil bonding.

(b) The antistatic agent

TABLE XI
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
COTTON

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Blower	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Durable Fire Retardant	56%	101%	281%
Melamine Formaldehyde	75	96	90
Semi-Durable Water Rep	93	100	77
CMC	107	98	136
Wax Repellent	205	170	175
Starch	96	90	112
Mercerization	174	97	88
Durable Water Repellent	158	73	91
Water Rep & Resin Finish	85	79	51

TABLE XII
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
ACETATE

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Blower	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Antistatic	128%	126%	145%
Antifume	104	103	103

TABLE XIII
EFFECT OF TREATMENTS AND FINISHES
FLAT FABRICS
VISCOSE

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Blower	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Urea Formaldehyde	55%	92%	85%
Wax Repellent	136	100	165
Glyoxal	79	99	104
Cationic Softener	68	102	102

TABLE XIV
EFFECT OF TREATMENTS AND FINISHES
PILE FABRICS
WOOL

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Floor Service 5 Days	10 Days	20 Days	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
0.2% Synthetic Lubricant*	149%	138%	135%	123%	
0.5% Synthetic Lubricant*	153	144	144	120	
1.0% Synthetic Lubricant*	160	146	142	112	
2.0% Synthetic Lubricant*	163	151	147	107	
1.0% Vegetable Oil	167	159	149	118	
1% Lard Oil	173	164	153	115	
Cationic Antistatic	105	112	108	119	
Cationic-Anionic Antistatic	119	113	114	129	

* Sulfonated Mineral Oil Blended with Mineral Oil

TABLE XV
EFFECT OF TREATMENTS AND FINISHES
PILE FABRICS
NYLON

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Floor Service 5 Days	10 Days	20 Days	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Cationic Antistatic	86%	85%	89%	95%	
Synthetic Lubricant*	103	104	105	104	
Cationic-Anionic Antistatic	95	94	98	99	

* Anionic Softener

showed ambiguous results within the tumbler test.

(4) Acetate Fabric:

(a) Both antistatic and antifume treatments increased soiling slightly.

(5) Viscose Fabric:

(a) Urea-formaldehyde-treated fabrics showed improved soil resistance by both test methods.

(b) The wax-repellent finish increased soiling, probably by oil bonding in both test methods.

(c) The glyoxal treatment and cationic softener showed little effect on soiling.

E) *Tests Made on Both Tumbler and Floor Tests*

1) Experiment TF1

a) *description:* the 5 pile fabrics were given various treatments and finishes, following which they were exposed to both tumbler and floor service tests.

b) *purpose:* to compare the sensitivities of tumbler and floor tests toward the effects of treatments and finishes on the soiling properties of pile fabrics.

c) *procedure:* standard tumbler and floor soiling tests. On the latter, 5-, 10- and 20-day exposures were made.

d) *results:* See Figures 16-23 and Tables 14 through 18.

e) *conclusions:*

(1) Wool Fabrics

(a) Figure 16 clearly shows the effect of oil bonding and the sensitivity of both tests to revealing it. The floor soiling tests showed high early soiling, which increased with the amount of oil on the fiber. It is interesting to note that the amount of soil is reduced with longer floor-exposure times. It is possible that some of the oil is removed with soil particles during daily vacuum cleaning, and a lower equilibrium level is gradually established on the carpet.

(b) the other four treatments on wool carpets all show increased soiling, presumably by oil bonding. The antistatic materials showed much less effect by the floor test than the oils.

(c) the effects on soil retention of vegetable, animal, and mineral oils are comparable.

(5) Viscose Fabrics

(a) Both test methods with CMC and soap applied in alkaline condition showed improved soil resistance.

(b) Soap applied to a test specimen already treated with acid, as for instance in dyeing or scouring, soiled worse by both tests. The application of free fatty acid from solvent produced similar and consistent results. This agrees with the observation in the rug cleaning trade that soap applied to acidic

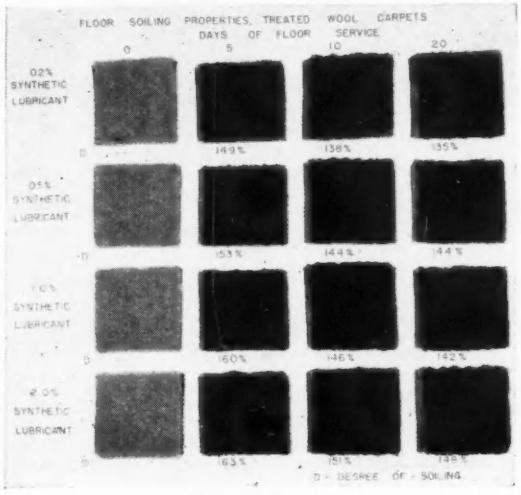

Figure 16
Experiment TF₁

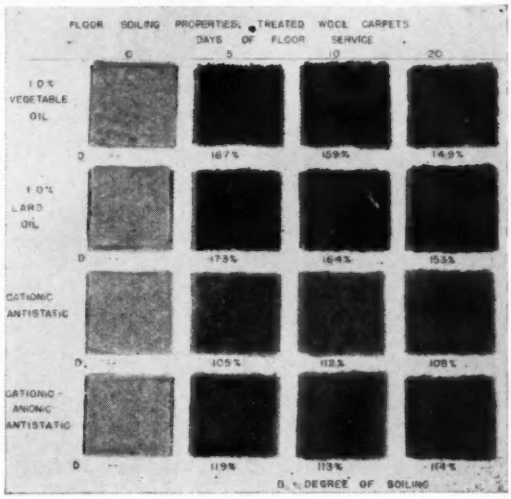

Figure 17
Experiment TF₁

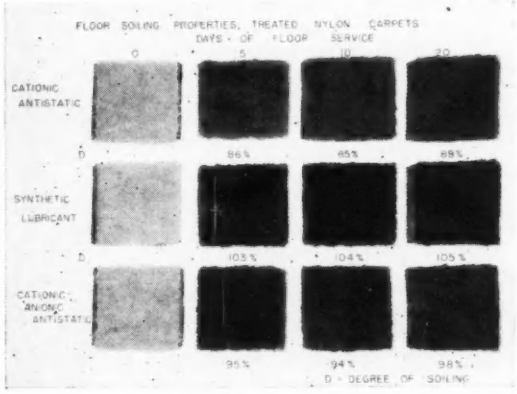

Figure 18
Experiment TF₁

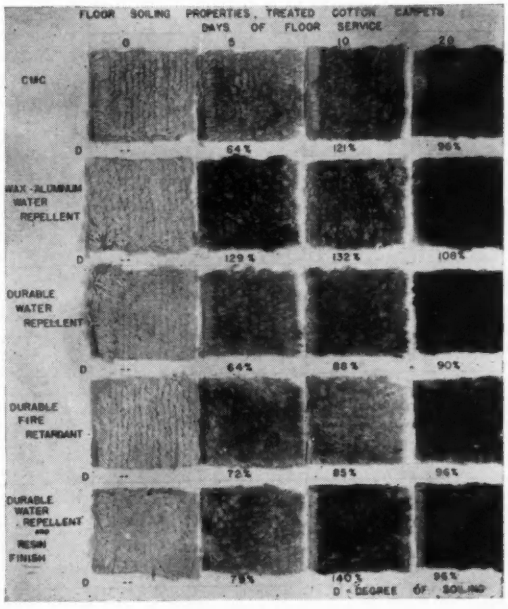

Figure 19
Experiment TF₁

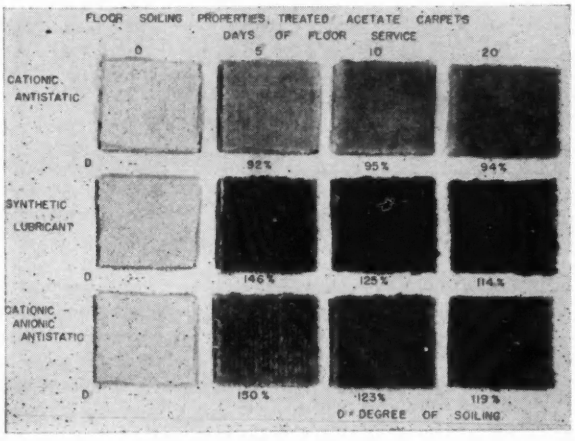

Figure 20
Experiment TF₁

carpet fibers breaks down to free fatty acids and causes undesirable soiling later.

(c) Of the remaining four treatments, data are reasonably consistent between the two test methods for all except one case.

SUMMARY AND CONCLUSIONS

A) A review of literature and projects on studies concerned with textile soiling produced 24 references. Most prominent

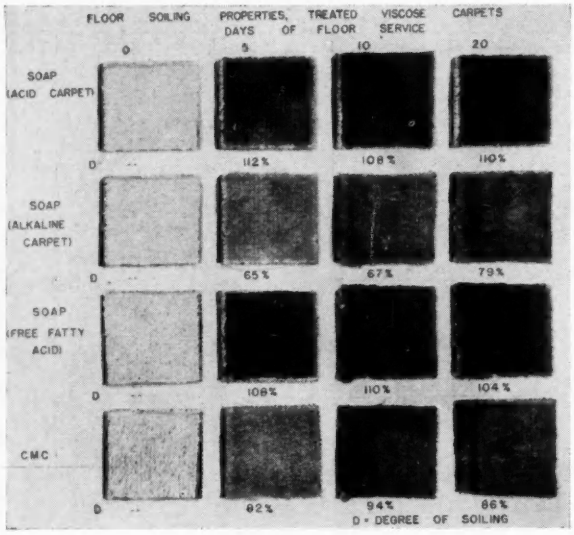

Figure 21
Experiment TF_1

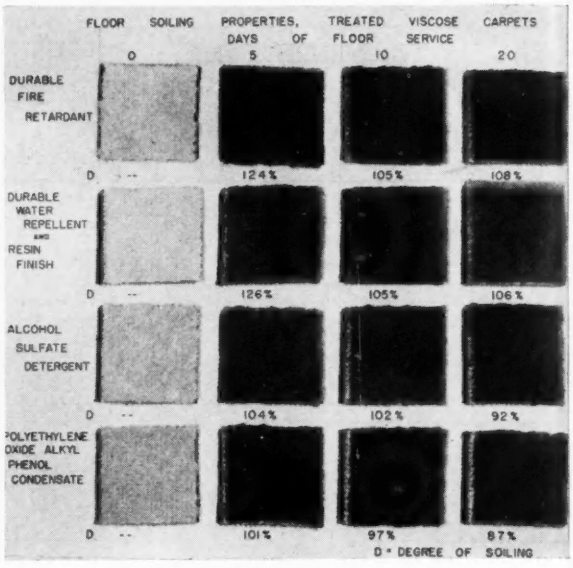

Figure 22
Experiment TF_1

TABLE XVI
EFFECT OF TREATMENTS AND FINISHES
PILE FABRICS
COTTON

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Floor Service 5 Days	10 Days	20 Days	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
CMC	64%	121%	96%	83%	
Wax-Aluminum Water Rep	129	132	108	115	
Durable Water Rep	64	88	90	102	
Durable Fire Retardant	72	85	96	111	
Water Rep & Resin Finish	79	140	96	110	

* Reflectance Measurements difficult due to Texture & Surface Character

TABLE XVII
EFFECT OF TREATMENTS AND FINISHES
PILE FABRICS
ACETATE

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Floor Service 5 Days	10 Days	20 Days	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Cationic Antistatic	92%	95%	94%	127%	
Synthetic Lubricant*	146	125	114	132	
Cationic-Anionic Antistatic	150	123	119	135	

* Anionic Softener

TABLE XVIII
EFFECT OF TREATMENTS AND FINISHES
PILE FABRICS
VISCOSE

Treatment or Finish	$\frac{\Delta R_T}{\Delta R_B}$ Floor Service 5 Days	10 Days	20 Days	$\frac{\Delta R_T}{\Delta R_B}$ Tumbler	$\frac{P_T}{P_B}$ Tumbler
Durable Fire Retardant	124%	105%	108%	106%	
Water Rep & Resin Finish	126	105	106	91	
Alcohol Sulfate Det	104	102	92	106	
Nonionic Detergent	101	97	87	89	
Soap (Acid Carpet)	112	108	110	104	
Soap (Alkaline Carpet)	65	67	79	79	
Soap (Free Fatty Acid)	108	110	104	122	
CMC	82	94	86	99	

among the conclusions that can be made from these references is a breakdown of factors in soiling between the two mechanisms of impingement and retention. The specific mechanisms within these groups may be listed as follows:

Mechanisms of Impingement

1) Diffusion of very small particles from air.

2) *Deposition* of medium and large particles from air.

3) *Direct transfer* of particles from a soiled surface.

4) *Interception* of particles in an air stream.

5) Contact by *inertial effect* with particles in a moving air stream.

6) *Electrostatic attraction* either from air or from another surface.

Mechanisms of Retention

1) Mechanical *occlusion*

2) *Oil bonding**

3) *Electrostatic Forces*

* While this is the term most commonly used, the true nature of this mechanism is likely related to surface-tension bonding by any type of liquid, greasy or waxy film. The broader interpretation of this mechanism probably accounts for the greater soiling tendency of wet fabrics as compared with dry ones.

B) Three test methods were described and specified. A group of illustrative examples showing their possible application was described:

1) A blower test, which causes impingement of soil from an air stream by interception and inertial effect. The results have shown that

a) the test results are very sensi-

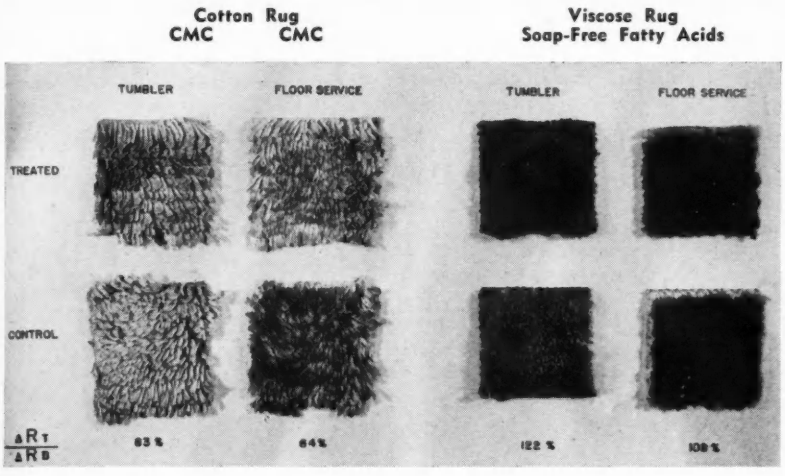

Figure 23

Representative Results From Experiment TF_1—Effect of Treatments & Finishes; Relative Soiling in Tumbler & Floor Tests

tive to fabric construction. For this reason, the blower test probably cannot be used to evaluate soiling tendencies of fiber types. It may be adaptable, on the other hand, to the relative evaluation *as a whole* of flat fabrics that have appreciable air permeabilities.

b) the blower test results are affected by treatments and finishes applied to flat fabrics. The results shown where oil bonding would be anticipated to cause increased soil retention are in agreement with the references cited. results of the tests on the other two test methods, and expected results.

c) results on tests made with constant volume and varying velocity are in agreement with reference *(3)*, which states that impingement of air-borne soil particles increases with air velocity.

d) with a fixed driving force (power input to the blower), air permeability of the test fabrics determined the volume of air that went through the specimens. It was shown that a tighter fabric resisted the passage of air and produced less soiling. This is in agreement with reference *(9)* wherein Krueger states that a tight fabric permits lesser penetration of soil.

e) for reasons stated above, the blower test may be useful as a tool to design flat fabrics with improved soiling resistance under certain service conditions.

2) A tumbler test, which causes impingement of soil by deposition and transfer (probably also some direct interception). The test results have shown that:

a) the tumbler test is less sensitive to differences in fabric construction than the blower test, as shown by the closer grouping of results on three woolen flat fabrics. Therefore, the tumbler test may be useful for evaluating soiling tendencies of fiber types.

b) the tumbler test is sensitive to the effects of treatments and finishes. Treatments of an oily nature produced increased soil retention as expected of oil bonding.

c) the tests made involved the use of a simple synthetic soil subject to analysis by reflectance and by titration to give absolute pickup. Retention tests on untreated flat fabrics showed satisfactory lack of selective absorption. This result agrees with those of tests made at the Philadelphia Quartermaster Laboratories and indicates the suitability of simple soils in contrast to complex mixtures which have been made to simulate natural soils *(16)*.

3) A floor test, which produces impingement principally by deposition and transfer:

a) test results have shown differences among specimens of similar construction made with various types of pile fibers.

b) results expected of oil bonding as a factor in soil retention were obtained. These results are in agreement with references *(11)* and *(12)*.

c) since the floor test is in reality a service test with standardized procedure, it offers little difficulty in relating test results with service conditions. Although the floor test has a narrow field of direct application, namely, to floor covering fabrics, it may offer a good opportunity for checking the results of the other two test methods against service conditions of certain types. This may especially apply to comparison with the tumbler test where soil impingement is also principally incurred by deposition and transfer.

d) a comparison of results among the three test methods does not produce a clear-cut conclusion on the effects of many finishes. This fact strengthens two cautionary statements made early in this paper:

(1) that general conclusions as to the effect of fibers and finishes on soiling properties of fabrics should not be made from these results;

(2) that the results of any one test method may not give a satisfactory picture of the results that the same fabric would give under service conditions. An analogous case exists in the evaluation of rain wear as to water resistance, wherein a battery of tests may be used to determine spray resistance, drop penetration, and hydrostatic resistance. No single one of these tests will satisfactorily rank the performance of rain wear in service and the persons most familiar with the tests recommend making conclusions by judiciously interpreting the results of all three.

It was stated early in the paper that a test method must produce the *effects* of service conditions. The conditions themselves are usually simulated in the hope of reproducing the effects unless the mechanisms involved are sufficiently well understood to permit circumvention of this roundabout approach. Only then can a single test method be used in place of a battery of tests, each of which aims to reproduce certain limited groups of service conditions.

If this philosophy is applied to the results of the three soiling tests shown here, it is clear that the mechanisms of soiling are not yet sufficiently well established in all their details to permit of a single test method. The tumbler test may prove to be the nearest possible approach to a universal method of soiling evaluation, but its results do not agree in all cases with those of the blower test. It can be said for the tumbler test that it has the advantage of greatest potential reproducibility among the three test methods described since the test conditions as well as the test procedure can be standardized. As specified here, the blower and floor tests in their present state of development are subject to standardization with respect to procedure only but not with respect to conditions. Because the mechanisms of impingement are essentially the same, the tumbler test and floor test may be interchangeable on floor-covering fabrics. The vigorous mechanical action of the floor test renders it unsuitable for most flat fabrics. The tumbler test may be more applicable to flat fabrics, except for those fabrics that have appreciable air perme-

ability and whose use in service subjects them to impingement of airborne soil. In this case, the blower test may be the best.

C) The Committee therefore believes that these three test methods are practical tools adaptable to the study of soiling, which, as a textile performance factor, has heretofore been considered to a lesser degree than such other factors as color fastness, abrasion resistance, crease resistance, drape, etc. The increased use of functional treatments and finishes over the past 20 years has undoubtedly had a bearing on fabric soiling, which has never been carefully evaluated. The development of synthetic-fiber types offers another opportunity for application of soiling-evaluation tests.

D) Several steps for development of the three test methods and their further application immediately suggest themselves:

1) The application of soils with graded particle sizes to the tumbler test would yield further information on soiling by different mechanisms and retention of different particle sizes.

2) An attempt could be made to standardize the conditions of the blower test by artificially generating air-borne particles for supply to the blower and thus provide a standardized atmosphere. This approach might offer an opportunity for the study of electrostatic effects which are obscure at the present time *(3, 14, 7, 10)*.

3) Service tests aimed at comparison with the effects of treatments and finishes found above are necessary for establishment of correlation.

4) Utermohlen et al *(24)* have shown a logarithmic relation between amount of soil and reflectance changes. The tumbler test offers a good opportunity for further exploring the relation between reflectance changes and absolute soil pickup. In the evaluation of soiling, there is disagreement in the field of optics as to whether absolute and relative measurements are equally "real". The layman is primarily concerned with apparent soiling but the technician realizes that scientific improvements are more readily achieved by dealing with absolute quantities. So little is known about the particular aspects of soiling that we can do no more than recommend investigation by all possible avenues. This would mean a comparative study of both relative and absolute soiling until an organized body of knowledge is built up. At this point the study of soiling could be called a science.

5) Many conclusions other than those written here can be drawn by the student who wishes to examine the data further. For instance, the tumbler and floor tests showed viscose fabrics to soil more than any of the other fibers. Examination of Figures A and B in Appendix 2 shows the viscose fibers in both flat and pile fabrics to have the more irregular contour of the various fibers studied. This indicates agreement with Masland's studies *(13)*. The acetate fabrics also showed considerable soiling, and it will be observed that the contour of the acetate fibers is similar to that of the viscose fibers. Thus, an opportunity is offered to the manufacturers of synthetic fibers for a broad field of investigation.

ACKNOWLEDGMENTS

The Committee expresses gratitude to Ray Diaz of Colgate-Palmolive-Peet for contribution of time by his laboratory staff to reflectance measurements; to S J Kennedy, John Davies and Elliott Snell of the Quartermaster Research & Development Division for permission to describe the Quartermaster work on soil evaluation and for information on the project; to Jack Compton of ITT for guidance and suggestions on our description of the U S Department of Agriculture project on cotton soiling, which his staff is conducting; and to the many laboratory personnel who have prepared test fabrics, conducted analyses, compiled data, illustrations, etc.

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APPENDIX 1

Experiments Connected with Development of Tests

Conditions specified in the test methods of Part III, were arrived at by experiments which screened several variations thereof. Method 3, the floor soiling test, is an exception. Other than changing specimen size, method of assembly, or exposure locations all of which are arbitrary, little variation can be made that would affect the principle of the test.

For the other two test methods, a few experiments which led to the specified conditions are described:

A) BLOWER TEST

1) Comparison of specimen mounting at inlet versus outlet end of blower tube. Early experiments compared the soiling of oil-treated flat fabrics with controls, at either end of the blower tube. Mounting specimens at the outlet end was found unsuitable for two reasons:

a) soil is unevenly distributed over the specimen. The motor casts a negative "shadow" or unsoiled area at the center of the specimens, which gradually fades toward the perimeter of the tube to a more heavily soiled ring. This ring is neither sufficiently uniform nor broad enough to permit reflectometer measurements.

b) sensitivity to differences in soiling tendency is poorer than by mounting at the inlet end. Specimens treated to retain soil by oil bonding showed good differentiation against their controls in the tumbler test, floor test, and blower test when mounted at the inlet end, but practically no differentiation at the outlet end.

2) Comparison of "permeable" versus "nonpermeable" soiling tests were made on specimens mounted not on the blower tube but rather on a solid backing a short distance from the outlet end of the blower tubes, thus causing the air stream leaving the tube to blow on the cloth. Vertical mountings 1" to 6" from the tube were tried, and also 45-degree mountings with centers 3" to 6" from the tube. Prolonged exposures up to 8 hours of such mountings showed no evidence of soiling on specimens that soiled well in 2 hours by the specified procedure. It is concluded that the specimens cannot be soiled rapidly unless the air goes directly through them; and that in nonpermeable mounting, skin friction produces a layer of stationary air close to the fabric surface, which sharply reduces impingement. Another experiment would be interesting, in which the cloths are mounted as described above, but on an open frame rather than a solid backing; such that the permeability of the cloth will determine the fraction of air that will go through and the fraction that will be reflected.

3) *Estimate of Impingement by Diffusion.* Specimens of the 7 flat fabrics with and without the finishes described in Part III, were hung vertically out of drafts for 6 months in the same laboratory (industrial atmosphere) where blower tests produced results in Part IV with 2-4 hours' exposure. At the end of six months no visible soiling had taken place. It is concluded that particles smaller than 0.1μ, which impinge by diffusion, were present in such low concentration as to contribute insignificantly to soiling. This concurs with the conclusion of Compton & Hart (7) that particles smaller than .05μ are not commonly encountered in service conditions.

B) TUMBLER TEST

1) *Reproducibility Tests.* Specimens of wool, cotton, nylon, acetate, and viscose flat fabrics were treated with an agent to promote oil bonding and were tested with their controls on five separate days. Visual reproducibility was satisfactory. Reflectometer and sulfate analyses were not made.

2) *Soil Pickup by Weight Increase of Test Specimen.* Before adoption of the sulfate titration to get soil pickup in tumbling, analysis by weight increase was attempted. Average soil pickup of 75 specimens of flat fabrics by sulfate analysis ran 3%, with a range among all specimens tested of 0.65 to 12.93%. Pickup by weight increase was found to be overshadowed by changes in moisture regain when specimens were weighed in an uncontrolled atmosphere. Sulfate analysis was adopted as a more accurate procedure.

3) *Comparison of Artificial Soiling Mixtures.* Before the specified soil containing 50 grams anhydrous sulfate and 5 grams animal charcoal was adopted, several other agents were compared for suitability. They were as listed in Table A. This left a choice among 5 grams animal charcoal with either sodium sulfate, or borax or calcium carbonate. Sodium sulfate was finally chosen on the basis of the

TABLE A

Soil Composition	*Soiling Properties*	*Analysis of Pickup*
a) 50 grams NaCl and 5 grams animal charcoal	Uniform & Measurable	Direct titration impractical
b) 50 grams NaCl and 20 grams animal charcoal	Too Dark	Direct titration impractical
c) 50 grams borax and 55 grams animal charcoal	Uniform & Measurable	Can be titrated with standard acid
d) 50 grams borax and 20 grams animal charcoal	Too Dark	Can be titrated with standard acid
e) 50 grams starch and 5 grams animal charcoal	Uniform & Measurable	Simple determination unavailable
f) 50 grams starch and 20 grams animal charcoal	Too Dark	Simple determination unavailable
g) 50 grams $CaCO_3$ and 5 grams animal charcoal	Uniform & Measurable	Can be titrated with acid
h) 50 grams $CaCO_3$ and 20 grams animal charcoal	Too Dark	Can be titrated with acid
j) 50 grams clay and 5 grams animal charcoal	Too Light	No simple analysis procedure
k) 50 grams clay and 20 grams animal charcoal	Too Light	No simple analysis procedure
l) 50 grams sodium sulfate and 20 grams animal charcoal	Too Dark	Sulfate titration

TABLE B
CONSTRUCTION OF TEST FABRICS

I) Flat Fabrics

A) Weave, counts, and weights

Identification	*Frazier Air Permeability*	*Weave*	*Total Weight (Oz/Sq Yd)*	*Warp Count (ends/in)*	*Filling Count (ends/in)*
Wool gabardine	82.4	Twill	5.5	61	51
Wool flannel	126.0	Twill	6.1	53	46
Wool challis	191.0	Plain	3.2	61	57
Nylon	39.3	Plain	2.8	113	76
Acetate	109.0	Plain	5.6	60	38
Viscose	210.0	Plain	3.7	76	69
Cotton	171.0	Plain	3.9	66	60

B) Yarn construction

Identification	*Warp Size*	*Warp Twist*	*Filling Size*	*Filling Twist*	*Staple or Filament*
Wool gabardine	17s/1	4.6	19s/1	4.3	Staple
Wool flannel	19s/1	6.8	11s/1	5.7	Staple
Wool challis	26s/1	6.0	24s/1	5.4	Staple
Nylon	62s/1	..	33s/1	..	Filament
Acetate	23s/1	3.3	24s/2	3.6	Staple
Viscose	31s/1	6.3	29s/1	6.8	Staple
Cotton	27s/1	7.1	22s/1	6.6	Staple

II) Pile Fabrics

A) Weave, counts, and weights

Identification	*Weave*	*Total Weight (Oz/Sq Yd)*	*Pile Weight (Oz/Sq Yd)*	*Backing Wgt (Oz/Sq Yd)*	*Warp Count (Ends/in x 27")*	*Filling Count (ends/in)*
Wool	Axm	63.9	29.5	34.4	189.0	6.9
Nylon	Axm	63.5	29.5	34.0	189.0	6.9
Acetate	Axm	69.6	32.4	37.2	189.0	6.9
Viscose	Axm	58.9	26.8	31.1	189.0	7.0
Cotton	Needled	35.2	26.3	8.9	351.0	6.0

B) Yarn construction

Identification	*Pile Yarn Size*	*Pile Yarn Twist, Plied*	*Staple or Filament*
Wool	1.05s/2	1.53	Staple
Nylon	1.05s/2	1.53	Staple
Acetate	1.05s/2	1.53	Staple
Viscose	1.05s/2	1.53	Staple
Cotton	6.52s/3	5.0	Staple

available titration procedure and more uniform soiling of test specimens.

4) *Comparison of Soil Weights and Tumbling Time.* Comparisons of a few combinations were made.

Soil weight (gms)	*Tumbling Time (min)*	*Results*
5	15	Good
50	1	Good
1	60	nonuniform

On the basis of results above, 5 grams at 15 minutes was chosen.

5) *Selectivity of Absorption.* It was considered possible that the soiling might be compromised if sodium sulfate or animal charcoal should be selectively absorbed onto the test specimens. This was covered by running successive untreated test specimens of flat fabric with the same soil until half of the original soil mixture was used up. The remaining soil was then analyzed and found to have the same composition as originally. It was thus concluded that selectivity does not occur on flat fabrics.

This was not found to be true of pile fabrics; in some cases the animal charcoal was preferentially absorbed leaving a mixture richer in sodium sulfate. In the running of pile fabrics, therefore, fresh soil was used for each set of specimens.

6) *Knitted Yarns on Blower Test.* The same yarns used to make the face of the pile fabrics were knitted to produce specimens for tumbler and blower tests. This was an attempt to derive more information on comparative results among the three test methods. It was found impossible, however, to make knitted cloth of sufficiently uniform construction for satisfactory blower tests. The yarns made of the five different fibers showed widely different tendencies toward elongation and tightness of knit and also produced varying degrees of nap on the surface of the finished fabrics. ΔR results from the blower tests of these fabrics were inconsistent among themselves, and it was concluded that construction differences prevented the collection of useful data.

APPENDIX 2

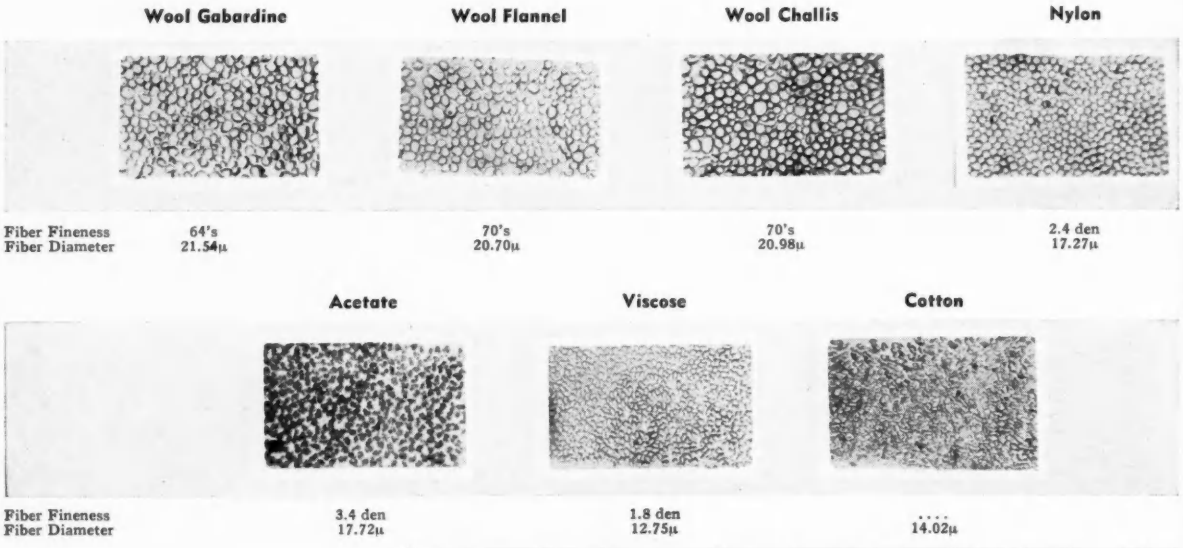

Figure A
Cross-Section of Fibers From Flat Fabrics
(Magnification = 225x)

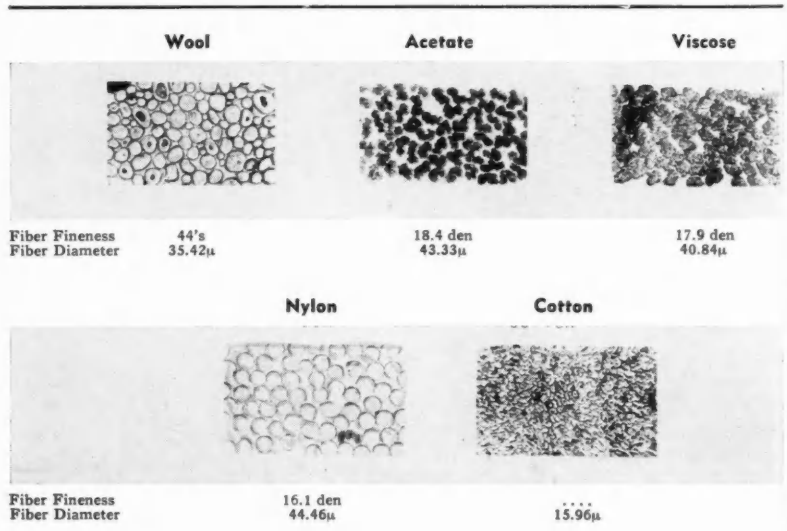

Figure B
Cross-Section of Fibers From Pile Fabrics
(Magnification = 225x)

30th Annual Convention
Auxiliaries and Testing Group——

THE ENGINEERING APPROACH TO WOOLEN-FIBER LUBRICATION*

PAUL J MARTIN

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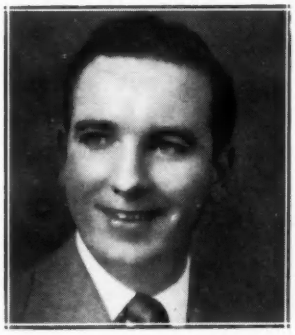
OVER the past twenty-five years emulsifiable mineral oils have in large part replaced straight fatty oils as lubricants for wool fibers. The change was not easily accomplished. To win over the champions of lard and olive oils, it was necessary for the supplier of emulsifiable mineral oils to know far more about his products and about woolen-mill processes than had ever been demanded of the suppliers of fatty oils. The successful supplier of mineral oils met the requirement, but his problem was complex. Just knowing his products and their limitations was not so easy as it might appear. Consider the possibilities in manufacturing a modern wool oil. Two basic components are involved: 1) a mineral-oil base to provide lubricity for the fibers and 2) emulsifiers to render the product "soluble" in water and easy to apply, and to assist in the removal of the oil from goods in scouring operations. The mineral oil used may be one of many highly refined oils that are stable to light, or conventionally refined oils that possess only moderate light stability. The emulsifiers may be one or more of the many sulfated vegetable and fatty oils, mineral oil sulfonates, soaps or special esters. Of all these possible combinations, the optimum formulations must be determined. This is accomplished by laboratory screening tests for certain critical characteristics, followed by more definite plant-scale tests.

Among the more important laboratory tests designed to predict a wool oil's suitability are the oil's emulsion characteristics; its stability to light; rancidity, and oxidation; its scourability or removability; its effect on condenser tapes and rub aprons; and its antistatic properties. The screening tests may be followed by mill-scale tests conductd by an independent agency. The results of a series of such tests conducted by the Lowell Textile Institute under the sponsorshop of Socony-Vacuum Oil Company, Incorporated, have been published *(1)*. Finally, the formulations are field-tested with the co-operation of commercial mills. Thus are good wool oils manufactured and proved, and thus does the supplier learn to know his products and their limitations.



Paul J Martin

Within the past two years, an approach to the proper use of wool oils has been successfully employed in woolen mills throughout the country, which is completely new in its comprehensiveness, attention to detail, and mode of attack. This system of technical service embraces all phases of woolen-mill processing that are affected by or that affect woolen-fiber lubricants. Particular attention is paid to the oil content and the moisture content of the stock from the picker house through the finishing department. Determination of these data is speeded through the use of a modern moisture meter recently adapted to woolen-mill requirements. Usage of this equipment eliminates tedious laboratory methods of determining moisture regain and makes it possible to run these evaluations in a matter of seconds. A survey embracing all important aspects of wool-oil application is presented to responsible personnel in the form of an engineering report. This report then forms a permanent record for the mill's file.

But, however well a supplier knows his products, their value cannot be realized by the woolen industry unless they are marketed and applied with careful regard to the details of operations in each mill as well as the idiosyncrasies of the products. For instance, if the light-stability and scourability requirements of a particular plant are not severe, it is folly to recommend an oil that is outstanding in these respects, for then the mill pays for performance it does not need. If, on the other hand, the mill processes require a superior oil, and the marketer, through lack of knowledge of his products or lack of appreciation of the mill problems, submits an inferior product, he renders a disservice, which will certainly cause delays in production and may end in serious financial loss to the mill. It is then essential that a disciplined approach to marketing wool oils be observed in order to protect not only the mill but also the reputation of the wool oils themselves from the harm that results from misuse. One large supplier of wool oils has recognized this fact and now markets its products with an engineering service that is, in effect, a fiber-lubrication service.

Engineering service in wool oils begins with an analysis of the mill's operations. From the blending room to the drier the fiber-lubrication specialist checks the nature of the blends, the moisture and oil content of the fibers, the condition of the condenser tapes and aprons, the strength and uniformity of the yarn, the efficiency of the scouring operations, and the nature of the dyeing processes. He investigates, also, the procedures for storing, handling and applying the fiber lubricant. He then prepares a written report to mill management in which he reviews the present procedures, makes recommendations for any changes in fiber lubrication procedures he thinks desirable and lists the benefits that the mill will experience as a result of the changes recommended. The report, when accepted by the mill, is followed by on-the-spot co-operation with mill personnel to implement the recommendations made.

The reports on mill procedures and the co-operative work with mill personnel that usually follows have done much to improve operations in many mills. Consider for example the problem of determining how much oil and water should be applied at the picker. It is certain that the amount of oil and moisture already in the blend before picking and the amount of moisture that will be lost between the picker and the card are important factors in deciding on the amount of oil and water that should be applied. Yet this information is often inaccurate for understandable reasons. In the rush of commercial production, the time-consuming determinations of oil and moisture content are often avoided. Mill personnel assume that the blend contains the same amount of oil and

* Presented at the 30th Annual Convention at the Hotel Statler, New York, N Y on October 19, 1951.

moisture as the previous lot. Too often, as this "easy" method is applied throughout the seasons and through many lots of wool, the assumption is far from the fact. As a result, the amount of oil and water applied may have little or no relation to the requirements of the process. Engineered fiber lubrication has helped to simplify this problem by using a Moisture Meter. This equipment, recently adapted to on-the-spot use in textile mills, makes it possible to determine the moisture content of a stock at any point in the mill in one or two minutes. Cumbersome laboratory methods are thus avoided. It is possible to determine quickly and accurately the moisture content of the stock at any point in processing. It is therefore possible to know the moisture content in the blending room and to determine how much moisture is lost between the picker and the card feed. With this information it is, in turn, possible to determine the correct amount of moisture that should be applied with the wool oil at the picker. And the value of controlling the amount of moisture in a blend should not be minimized. It has a definite influence on yarn strength. In one plant where the Moisture Meter was used for quick and accurate control, yarn strength was appreciably improved when the moisture content of the blend was adjusted to an optimum point: A 33 percent change in the amount of moisture applied at the picker brought a 12 percent increase in yarn strength in the spinning room.

A second example of the contributions of engineered fiber lubrication to efficient mill operation is a nomograph devised to simplify the computations involved in preparing and applying wool-oil emulsions. The arithmetic involved in determining oil-to-water ratios and the amount of emulsion to be applied per hundred pounds of wool is often so confusing to mill personnel that they are inclined to estimate such factors. It has been found that, after a period of use of the "estimate" method, the emulsion and its application are out of control. Checks of mill-personnel estimates of oil and water applications against actual laboratory analyses of emulsion application often show a large discrepancy between the two. Care in making the decision concerning how much oil and water should be applied is negated by lack of attention to the simple calculations required. The nomograph presented here can be used with any wool-oil blend to overcome this difficulty. When, through the careful analysis of mill operations, engineered fiber lubrication has been established with knowledge of 1) the amount of moisture on the wool blend, 2) the amount of moisture loss between the picker and the card, 3) the total amount of moisture desired on the wool after oiling, and 4) the amount of oil to be applied, the nomograph shows quickly the correct amount of emulsion to be applied per hundred pounds of wool. There is then little reason for inaccuracy in the preparation and application of wool-oil emulsions. Moisture is therefore applied in efficient quantities. Oil consumption is held to the desired economical level.

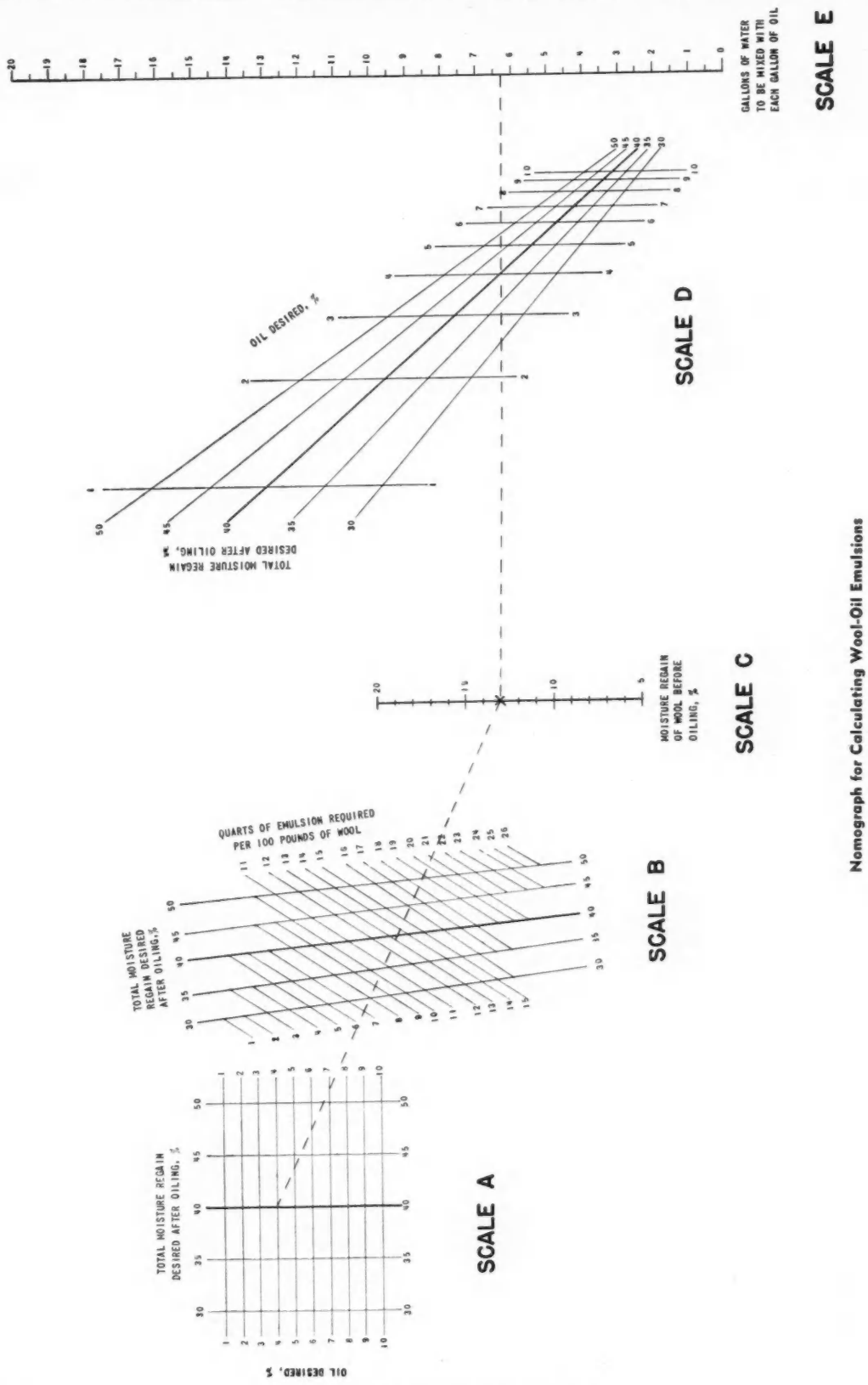
Nor is the engineering effort involved in fiber lubrication limited to wool oils and their application. It naturally branches out into such allied subjects as the effect of the wool oils on condenser tapes and aprons—a problem that became particularly important in the past five years. In this period many mills experienced a marked reduction in the useful life of condenser tapes and aprons due to cracking of the tapes and glazing of the aprons. A study of the mills experiencing difficulty showed that the problem was most acute in those mills using the so-called "self-scouring" wool oils. This fact confirmed the results of previous test work employing a specially constructed condenser-tape tester. In this work it had been established that oils containing large proportions of certain types of emulsifiers do shorten the useful life of leather condenser tapes and aprons. At the same time it was also established that the application of high-emulsifier-content oils should not exceed 4 percent of the weight of the wool, if acceptable condenser-tape life were to be expected. The results of this study were included in Koppenhoefer's paper entitled, "Factors Affecting the Service Life of Leather in Wool Processing" *(2)*. The importance of these data was reemphasized to the mills experiencing short tape life, and stricter control of the use of "self-scouring" wool oils corrected the difficulty in some cases. However, the mills found the answer in the use of a good-quality wool oil of the conventional type. The solution of this problem brought several benefits to the mills involved: 1) Reduced costs in materials and labor for replacing tapes and aprons, 2) less down time on the cards and hence greater production, and 3) better rub action in the condenser and more uniform roping and yarn.

The benefits derived by a mill from the engineering approach to wool oils are not limited to those resulting from the first analysis of mill oprations and the first cooperative effort in the mill. They continue through periodic reviews, which assure that the fiber-lubrication program remains efficient. The facilities of the suppliers' laboratories are enlisted regularly to control the oil and moisture content of the stocks. The efficiency of the scouring procedure is investigated and, when necessary, because of changes in mill schedules, recommendations are made for changes in lubrication procedures. Here too, as in the original analysis of mill procedures, the fiber-lubrication specialist places the results of his periodic reviews and his recommendations before mill management in a formal fashion in engineering reports, which avoid the misunderstandings so likely to occur in informal discussions in the mill.

With these regular contacts and reports, engineering service takes on the aspects of fiber-lubrication service, and mills justly come to rely on it and consider it an important part of the lubricants they purchase. The fiber-lubrication specialist is looked upon as the natural source of answers to the questions that are continually arising in the mill. Why doesn't the oil emulsify easily? Why is there scum on the surface of the emulsion? Does the new blend of fibers require the same amount of oil and water as the old blend? Can soap consumption be reduced? What are the advantages and disadvantages of "self-scouring" wool oils? Why is condenser-tape life so short? The fiber-lubrication specialist, in effect, relieves mill management of the necessity for concern with many of the details involved in preparing and applying wool-oil emulsions. Thus has engineering service, which stemmed from the necessity for convincing woolen mills of the advantages of emulsified petroleum oils, become an essential part of the marketing program of the successful supplier of wool oils.

A NOMOGRAPH TO SIMPLIFY THE CALCULATIONS INVOLVED IN PREPARING WOOL-OIL EMULSIONS

In woolen mills, the application of the correct amount of oil and the correct amount of water to fibers in the picker room is essential if carding and spinning operations are to be successful. Indeed, this phase of fiber lubrication may be quite as important as the choice of the correct fiber lubricant. Therefore, it is important to calculate with reasonable accuracy the ratio in which the required water and oil must be mixed in preparing the emulsion, and, finally, to calculate the amount of emulsion that must be applied per hundred pounds of wool so that the wool blend after oiling will contain the amount of oil and water decided upon. These rather troublesome computations, so necessary to efficient fiber lubrication, are made easier by the nomograph illustrated here. It should be of value to woolen mills in establishing oiling procedures and in periodic reviews of their fiber lubrication schedules.


SCALE E
GALLONS OF WATER TO BE MIXED WITH EACH GALLON OF OIL
SCALE D
OIL DESIRED, %
TOTAL MOISTURE REGAIN DESIRED AFTER OILING, %
SCALE C
MOISTURE REGAIN OF WOOL BEFORE OILING, %
SCALE B
QUARTS OF EMULSION REQUIRED PER 100 POUNDS OF WOOL
TOTAL MOISTURE REGAIN DESIRED AFTER OILING, %
SCALE A
TOTAL MOISTURE REGAIN DESIRED AFTER OILING, %
OIL DESIRED, %

Nomograph for Calculating Wool-Oil Emulsions

The nomograph is designed to simplify the calculation of the ratio in which the oil and water should be mixed for any operation and the amount of resulting emulsion that should be applied per hundred pounds of wool. It is assumed that a mill, in any real effort to obtain efficient fiber lubrication, has determined by laboratory analysis or knows from experience the moisture regain of the fibers before oiling, the moisture loss to be expected in picking and transportation to the card, and the moisture regain required at the card for efficient carding and spinning. (The latter two factors are difficult to ascertain directly and must sometimes be determined by trial and error in actual operation). It is also assumed that the percent oil to be applied to the fibers has been decided upon after due consideration of the percent oil in the fibers before oiling and the total percent oil required in the fibers at the card.

The use of the nomograph can best be illustrated by employing it to solve a typical mill problem.

PROBLEM—A wool blend of 13 percent moisture requires 4 percent of oil. It is assumed that 27 percent moisture regain is required at the card and, therefore, to compensate for a probable loss in regain of 13 percentage points before carding, 40 percent moisture regain will be required immediately after application of the emulsion. It is desired to determine 1) in what ratio the water and oil should be mixed in preparing the emulsion and 2) how many quarts of emulsion should be applied per hundred pounds of wool.

SOLUTION—Draw a straight line from 13 percent regain on Scale C thru the point on Scale D where the line for 4 percent oil intersects the line for 40 percent total regain; the intersection of this line with Scale E shows the number of gallons of water that must be mixed with each gallon of oil, in this case 6¼ gallons.

To determine the number of quarts of emulsion required per 100 pounds of wool, draw a line from 13 percent on Scale C to the point on Scale A where the line for 4 percent oil intersects the line for 40 percent total regain; the intersection of this line with the line for 40 percent total regain on Scale B shows the number of quarts of the 6¼ to 1 emulsion that must be applied per 100 pounds of wool fibers, in this case, 13½ quarts.

It will be noted that conditions of 40 percent total moisture regain and 13 percent original moisture regain have been used in the above example and have also been emphasized in the nomograph. These are normal conditions for a humidified mill; however, the nomograph has been drawn so that other values can be used with equal ease if the conditions of the operation justify.

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DISCUSSION

Question: How much emulsified mineral oil and how much fatty oil are used in the textile industry?

Answer: That is a difficult question to put to an employee of a petroleum company. From my own experience I would say that probably 90 to 95% of woolen and worsted mills in this country employ emulsifiable petroleum oils. I do not know the actual poundage for each type.

Q: How do you measure the fiber lubricity of a wool oil in the laboratory?

A: We use an apparatus developed by Milton Harris, which measures the coefficient of friction between fibers and a reference surface. This apparatus is called a fiber-friction meter and is described in reference *(1)*.

Q: Do you measure the antistatic properties of wool oils?

A: Yes, I mentioned the method in a previous paper *(1)*.

Q: How do you measure almost instantaneously the moisture content of wool?

A: We use an electrical device called the Hart Moisture Meter.

Meeting Report—Piedmont Section

April 26, 1952
Clemson House, Clemson, S C

THE Spring Meeting of the Piedmont Section was held at Clemson House, Clemson, S C, April 26th.

Over 70 members attended the Research Committee meeting at 10.00 AM presided over by Dr H Y Jennings of Dan River Mills.

Officers of the Section held a business luncheon meeting at 1:00 PM. Guests were National President C Norris Rabold and Donald Eccleston and D D Gagliardi of the Rhode Island Section.

The technical session was held at 3:00 PM in the auditorium of the new Chemistry Building at Clemson College.

Speaker: D D Gagliardi, Warwick Chemical Co
Subject: "New Chemical Finishing of Textiles"

This paper was followed by the Student Contest with the following results:

First Prize: "Dyeing of Orlon with Vat and Sulfur Colors" by J L Bridgman and P A Cook of Clemson.
Second Prize: "Effect of Soaping Operation on the Fastness Properties of Naphtol-Dyed Mercerized Cotton Yarn" by Roy Lee Moore, Jr, Clarence D Smith, and Bill Jay Wright, Jr of Georgia Tech.
Third Prize: "Sizing of Staple Orlon and Dacron" by W C Wylie of Clemson.

The paper by Bridgman and Cook will compete at National Convention in Boston with Student papers from other Sections.

George McElroy, manager of the new Owens-Corning Fiberglas Plant at Anderson, S C was guest speaker at the evening banquet at which Chairman Hobart Souther presided. Over 175 were present.

Arrangements for the Student Contest were very capably handled by Bob Smith of High Point Chemical Company; for the general meeting, John Beattie of Abbeville Mills, Abbeville, S C.

Respectfully submitted,
M M McCANN, *Secretary*

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Piedmont Section Outing Program

THE following program has been announced for the Piedmont Section's Summer Outing, which will be held June 6-7 at the Ocean Forest Hotel, Myrtle Beach, S C:

Friday, June 6th

9:30 PM Patio-dancing

Saturday, June 7th

Registration—Morning and Afternoon
10:00 AM Research meeting
11:00 AM Officers meeting
12:00 Noon Ladies Cocktail Hour
1:00 PM Ladies Luncheon
3:00 PM Ladies Party
7:30 PM Banquet
9:30 PM Patio-dancing

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Mid-West Outing Set for June 14th

A SOFTBALL game featuring the umpiring of A F (Brooklyn) Blackburn will be one of the highlights of the Mid-West Section's 20th Annual Outing on June 14th at Lake Lawn Lodge, Delavan, Wis. The usual golf and horseshoe pitching are also slated.

Frank F Myers heads an Outing Committee consisting of G B Chabot, Jr, W D Paine, V C Braun, K P Ferguson, E W Camp, L B MacFarland and Louis Hoehn, Jr.

ONE-HUNDRED AND SEVENTY-FIRST GENERAL RESEARCH COMMITTEE MEETING

THE 171st meeting of the General Research Committee was held at the Hotel Commodore, New York, N Y, on Friday, April 18, 1952.

At approximately 1:30 pm a moving picture was shown entitled "Waters of the Commonwealth". This picture, produced by the Commonwealth of Pennsylvania, pointed up the progress made during recent years in the elimination of pollution of streams and, consequently, the improvement of surface waters of the state. It was shown as a preliminary to discussions held later during the meeting.

At 2:05 pm Leonard Little, Chairman of the Committee, opened the formal meeting. He reported on recent activities of the Executive Committee on Research, referring to the preparations for a meeting of the International Standards Organization at Columbia University in June, which will cover shrinkage in laundering and physical methods of testing cloth, as well as additional meetings in November on color fastness. He also referred briefly to Mr Seibert's work on light fastness with particular reference to hydrophobic fibers.

It was announced that the June meeting of this committee will be held on the 12th and 13th in New York; the following meeting will be held in Philadelphia, September 11 and 12.

Reference was made to the first of the technical bulletins in the new covers being sent to corporate members and members of this committee. The second release is expected in June.

Mr Little stated that interest has been expressed in having Part III of the *Year Book* issued as a separate publication, i e, the part containing the tentative and standard testing methods. It was felt that these separate sections would be more suitable for actual laboratory bench use than the complete *Year Book*. After discussion it was generally concluded that it is desirable to encourage such separate publication of Part III.

Dr H W Stiegler, Director of Research, requested that chairmen of subcommittees keep the members of the committees advised of actions taken, since some members find it impossible to attend all meetings. He also advised that the Olney Library is now housed in the library at Lowell Textile Institute and will be serviced, catalogued, and where necessary, rebound. AATCC reserves rights to the books, but they will be available for student use, as well as for use by Association members.

Dr Stiegler advised that trade-mark and patent papers are being prepared for official signature on the Accelerotor, and that further improvements have been made to the dynamic dimensional change meter. He further advised that AATCC would be represented by an exhibit at the annual meeting of the Canadian Association of Textile Colourists and Chemists, showing the smaller instruments that we sponsor. It was also announced that the *Year Book* is nearly ready for the printer. Other references were made by Dr Stiegler relative to the formation of new subcommittees on bleaching, antistatic finishes and hygienic finishes and the possibility of the formation of one on stream pollution.

Dr Stiegler then presented a problem that had been referred to him from the Home Economics Group at Ohio State University. The difficulty, particularly prevalent in the Middle West, is a distinct changing in shade of fast dyed cotton when dried in gas-fired home dryers. The same fabrics, when dried in electric dryers, apparently do not suffer a change. Of the fabrics exhibited, most were blue shades. It was postulated that probably most of the difficulty arises in regions where natural gas is in use. Since there has been a great increase in the use of natural gas in the East, it may be expected that the difficulties will come up in that region. The problem is being referred to the Subcommittee on Atmospheric Gases for preliminary study. Dr Stiegler stated that there seems to be no slowing of problems within our sphere of activities. He concluded with a reference to the remodeling of AATCC laboratory space at Lowell.

C A Sylvester, Chairman of the Subcommittee on Wash Fastness, reported that results of the recent balloting on the new 4A test constituted approval. His committee has prepared the proposed new 2A test for submission by letter ballot, and also for inclusion in the next *Year Book*. This test is conducted for 45 minutes at 120° F in a bath containing 0.2% soap, 0.2% meta sodium silicate conc, and 50 stainless steel balls in the new stainless steel tubes of the Launder-Ometer. It is intended to duplicate in one test the result of five commercial launderings appropriate for manufactured fibers. Mr Sylvester expressed his appreciation for the efforts at Lowell in making this progress possible.

Mr Little then exhibited gray scales prepared in paper, which seemed to be very good and usable. These were circulated for the information of the committee members.

J F Warner, Chairman of the Subcommittee on Dimensional Changes, made a progress report, which indicated that his committee is still concentrating on the development of accelerated tests for determining wash shrinkage of woolen and worsted fabrics. For woven woolen fabrics they expect to recommend that the present Tentative Test Method 41-49 be accepted as a Standard Test since experience over the past two years has demonstrated its value. Relative to wool hosiery, the committee feels that the test proposed by Mr Goodavage should be adopted as a temporary standard. The subcommittee is still at work on tests for knitted outerwear.

Mr Little, referring to the matter of stream pollution, stated that there seems to be justification in appointing a reference committee, one which would follow this matter for the information of the textile industry, but which would not attempt a research or experimental job. Mr Souther, who has had considerable experience in this field, agreed. Referring to work done some time ago under the auspices of the Textile Foundation at the Cone Mills, Mr Souther commented that the Ohio River Authority is using it as a basis. He emphasized the fact that individual plants can do much in their own installations to help alleviate this problem and also that local committees can assist. For many years it has been apparent that conservation of water is important. Mr Little advised that E A Leonard has offered to organize a committee for this purpose for AATCC, although he is not free to head it.

T E Bell, Chairman of the Subcommittee on Bleaching, referred to their second meeting, which was held the previous day. The previously-discussed program was formally approved and adopted. Specific portions were assigned to members to enable them to carry out tests and to recommend procedures for discussion by the whole committee at the next meeting.

This committee is now known as "Subcommittee on Bleaching" although it was previously termed "Subcommtitee on Peroxide Bleaching". Discussion on this report by Mr Freedman developed the fact that he has noted a tendency in the trade to claim bleach-fastness for colored fabrics. He expressed the opinion that this should be discouraged, as bleaching is considered of primary importance for white fabrics.

A E Johnson, Chairman of the Subcommittee on Drycleaning, presented a number of charts depicting the progress made by his committee thus far. They are trying to develop a method that will represent in one test the effect arrived at in practice by five commercial drycleanings. Inconel tubes in the Launder-Ometer are being worked on at Lowell. Solvent ratio, time and number of steel balls are being evaluated. The importance of conditioning of fabrics, temperature and abrasion factors have been recognized. The Committee is still searching for suitable fabrics, and in addition to the laboratory work, will ultimately make runs on substantial yardage at the Silver Springs Drycleaning Institute. Discussion developed the fact that local ordinances are tending to increase the ratio of drycleaning plants using perchlorethylene as a solvent, although the bulk of the work is still being done with Stoddard Solvent.

G Wiseman, Chairman of the Subcommittee on Standard Soils, stated that his committee had completed work on the history and background of the subject and is getting ready to draw up its report on cotton. This should be ready for open discussion at the next meeting.

Alden Nute, Chairman of the Subcommittee on Durable Finishes, reported progress, stating that some data were not available at the meeting the day before, but that it was the opinion of his committee that a tentative method should be ready for submission at the next meeting.

In the absence of T G Hawley, Chairman of the Subcommittee on Simplified Control Tests, E C Hansen stated that this committee is submitting for approval by the General Committee, two of the tests that they have worked up. Upon motion by Mr Hansen it was agreed that they would be circulated to the Committee in letter ballots. The first of these tests is a combined shrinkage and wash fastness test, which requires a sample only five inches square—the test being run in a Launder-Ometer. The second test is a rapid perspiration test. The usual perspiration test solutions are used and a piece of fabric three inches by three inches is used for each of the test solutions. One-half milliliter of the test solution is pipetted onto the specimen; this is then covered with a blotter and finally by a flat iron heated to 250° F. After five minutes the blotter is examined for the degree of color transference from the specimen. Inter-laboratory tests show that both of these tests are very useful and very simple but emphasis was placed on the fact that they are not to be considered replacements for the regular official standard tests covering these same properties.

There was some general discussion of possible new problems to be handled by this committee. Needle cutting and glazing in ironing appeared to be worthwhile problems for consideration.

K H Barnard, Chairman of the Subcommittee on Antistatic Finishes, stated that interest is growing in this subject, and he is at present forming a committee. He discussed the present methods of measuring the property, and stated that data as well as fabrics are being covered. He invited participation on the part of those interested.

At the request of Mr Little, C W Dorn reported for the Subcommittee on Flammability. He stated that the proposed New York and New Jersey state laws covering flammable fabrics appeared to be inactive at the present time. The NRDGA Bill is now in a committee of the House of Representatives and it is expected that public hearings will soon be held.

There being no further business, Mr Little closed the meeting at 4:00 pm.

Those present were:

L S Little, *Chairman*
H W Stiegler, *Research Director*
G H Schuler, *Secretary*

E J Allard
M J Babey
C A Baker
K H Barnard
T E Bell
G R Bellamy
J R Bonnar
A T Brainerd
W H Cady
H C Chapin
W E Coughlin
C W Dorn
C Z Draves
W C Durfee
E Freedman
A H Gaede
J M Gould
G J Greendonner, Jr
H E Hager
H C Haller
E Hansen
S L Hayes
W A Holst
G D Jackson, Jr
R W Jacoby
H Y Jennings
A E Johnson
J E Lynn
O F Marks
M M McCann
W R Moorhouse
J E Norton
A D Nute
A L Peiker
L C Reynolds
B A Ryberg
H G Smith
R B Smith
R H Souther
R B Stehle
C A Sylvester
P Theel
S G Turnbull, Jr
J F Warner
G Wiseman
P J Wood
H L Young

Meeting Report—Mid-West Section

April 19, 1952

Netherlands Plaza Hotel, Cincinnati, Ohio

THE Spring Meeting of the Mid-West Section was held at the Netherlands Plaza Hotel, Cincinnati, Ohio, on April 19, 1952.

The afternoon meeting, attended by 115 members and guests, was called to order by our Vice-Chairman, after which he introduced H G Smolens of the Becco Company. Mr Smolen's paper was "Peroxide Bleaching of Textile Materials".

The evening meeting was called to order by the Chairman, after which the Secretary's and Treasurer's reports were read and accepted. A report was given by the Chairman of the Corporate Membership followed by reports concerning the National Convention and our Annual Outing. A T Brainerd, Western Regional Vice-President introduced National President C Norris Rabold, who brought us up-to-date on the national affairs and problems of the AATCC. George D Fronmuller, Commonwealth Color & Chemical Company, concluded the program with a paper, "The Nature of Dyeing the New Synthetic Fibers".

Respectfully submitted,
VICTOR H LAWRENCE, *Secretary*

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Meeting Report—Southeastern Section

May 3, 1952

Ralston Hotel, Columbus, Ga

THE Southeastern Section heard three timely technical talks at their May 3rd meeting at the Ralston Hotel, Columbus, Ga.

In the afternoon session, Donald E Marnon, General Dyestuff Corporation, told of the unusual effectiveness of the Marhen Process (of vat dyeing) in controlling the dye bath, and also of the simplicity as to its operation. The second afternoon speaker, J A Woodruff, American Viscose Corporation, discussed the Avcoset Process for the stabilization of rayon fabrics. He pointed out that permanent retention of useful fabric dimensions during normal wearing and laundering could be achieved through chemical treatment of the fabric followed by relaxation shrinkage or compressive shrinkage.

The evening (banquet) session featured AATCC Vice-President Samuel Hayes, Ciba Co, who spoke on the work of the National Association.

Respectfully submitted,
J W SWINEY, *Secretary*

Meeting Report— Philadelphia Section

April 25, 1952

Berkshire Knitting Mills, Wyomissing, Pa
and
Abraham Lincoln Hotel, Reading, Pa

THE third meeting of the Philadelphia section was held on Friday, April 25, 1952.

Approximately 195 members and guests attended the afternoon session held in the Berkshire Recreation Hall of the Berkshire Knitting Mills in Wyomissing, Pa.

A tour of various departments of the host plant was made prior to the opening of the afternoon technical program which was under the chairmanship of Dr M J Reider.

William C Brenner, assistant to the Vice-President of Manufacturing, Berkshire Knitting Mills, welcomed the group.

Two papers were presented during the afternoon session. The first paper, "The Dyeing & Finishing of Hosiery" was given by Harold DeTurck, Supt of Dyeing and Finishing, Berkshire Knitting Mills, and the other, "Hosiery and the Endless March of New Fibers", by Virgil T Hartquist, General Manager, Jefferies Processors of Philadelphia.

The evening meeting was held in the Abraham Lincoln Hotel in Reading, Pa, with 333 members and guests at the dinner and approximately 358 at the technical meeting. The overall attendance of the afternoon and evening meetings was estimated at approximately 450, making this the largest meeting ever held by the Philadelphia section.

Guests introduced by Chairman E C Diehl included Rev C R Rahn, Pastor of the Jacksonville Charge; Honorable J B Bamford, Mayor of the City of Reading; A W Etchells, Vice-President of AATCC, Central Atlantic Region and Richard Cox, Philadelphia Textile Institute Dean.

Program Chairman T H Hart introduced the guest speaker of the evening, William G Knerr, Liberty Dye Works, Inc, who spoke on "Outlook and Trends in the Hosiery Industry".

Respectfully submitted,
THOMAS J SCANLON, *Secretary*

Principals in the April 25th Meeting, Philadelphia Section

Seated (l to r): Virgil T Hartquist, Jeffries Processors; Harold DeTurck, Berkshire Knitting Mills; Dr Malcolm J Reider, Geo W Bollman Co; William G Knerr, Liberty Dye Works.

Standing (l to r): Thomas W Hart, Hart Products; Thomas J Scanlon, Calco Chemical Division; Edward C Diehl, Ankokas Dyeing and Processing Co; William Brenner, Berkshire Knitting Mills.

James B Bamford (Center), Mayor of Reading, is greeted by a delegation from the Philadelphia Section at the Abraham Lincoln Hotel, Reading, Pa on April 25th.

(L to r): Alfred E Koch, Sandoz Chemical Works; Dr M J Reider, Geo W Bollman Co; Mr Bamford; Edward C Diehl, Philadelphia Section Chairman; and Thomas J Scanlon, Section Secretary.

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Meeting Report— Hudson-Mohawk Section

May 2, 1952

Jack's Restaurant, Albany, N Y

SEVENTY-TWO persons were on hand at the May 2nd meeting of the Hudson-Mohawk Section at Jack's Restaurant, Albany, N Y, to hear E Szlosberg, Sandoz Chemical Works, Inc, present a paper, "The Dyeing of Orlon", which introduced the so-called "Drip Method" of coloring the new acrylic fiber.

In addition to Mr Szlosberg's talk, a 16 mm sound movie, "Metachrome Dyeing with Metomega Chrome Colors" was shown. The film was prepared under the direction of Charles H A Schmitt, Director of Application Research and Development, Sandoz Chemical Works, Inc.

Sixty-one members were present for the dinner, which preceded the technical session.

Respectfully submitted,
WILLIAM A NELSON, *Secretary*

Meeting Report— Rhode Island Section

AT THE management meeting of the Rhode Island Section on April 25 at the Wannamoisett Country Club, Rumford, R I, His Excellency, Dennis J Roberts, Governor of the State of Rhode Island, gave a talk on "The Rhode Island Industrial Development Corporation", and George H Arris, Financial Editor of the Providence Journal and The Evening Bulletin discussed "Textiles — One Year Later".

The meeting was attended by 205 members and guests of the Section.

Respectfully submitted,
R G THOMAS, *Secretary*

RHODE ISLAND SECTION MEETING, APRIL 25, 1952
WANNAMOISETT COUNTRY CLUB

(Photos by John E Trezise)

(Photo by Kenneth C Everett)

Seated (l to r): Eric O Appeltoft, Vice-Chairman; Dennis J Roberts, Governor of the State of Rhode Island; Ernest J Chornyei (Bradford Dyeing Assoc —USA), Chairman.

Standing: Henry Coogan (left), manager of Cranston Print Works and Elliot Broadbent, general manager, Glenlyon Print Works.

(Photo by Kenneth C Everett)

George H Arris (left), Financial Editor of the Providence Journal and The Evening Bulletin, converses with Gov Roberts.

(Photo by Kenneth C Everett)

(L to r): Steven Madben and Carl Johnson, Cranston Print Works; Kenneth Broden, Sherwin-Williams.

(Photo by Kenneth C Everett)

(L to r): Edwin Parker and Charles Stokes, Carbic Color & Chem Co; James Redmond, Aridye Corp.

DYEING POLYAMIDE FIBERS WITH INDIGOSOLS

C TH SPEISER
Durand & Huguenin S A, Basle, Switzerland

INTRODUCTION

THE polyamide fibers are used nowadays in many industries, and are much in favor bacause of their high tensile strength in the wet and dry state, and on account of their great elasticity. Furthermore, they can be washed easily and dried quickly. They are specially appropriate for conditions where high mechanical strength is required, coupled with the need for a decorative effect, as they can be dyed and printed with colors which are fast to light.

Currently, polyamide fibers of the nylon type are generally dyed with water-insoluble dispersed dyestuffs and with chrome dyestuffs. The fastness properties of these colors are, on an average, fairly good. However, in many cases, the fastness to light of such dyeings is insufficient when compared to the resistance to wear and solidity of polyamide fibers.

Vat dyestuffs and sulfuric ester salts of leuco-vat dyestuffs—known as "Indigosols"—yield fast to light dyeings on nylon and other polyamide fibers, but, so far, require a somewhat complicated dyeing process. When not applied by such processes, which include a subsequent treatment of the developed dyeings, Indigosols and vat dyestuffs do not give fast to light dyeings.

GENERAL DYEING RECIPE

Polyamide fibers are dyed with Indigosols in a weak acid bath to which is added a reducing agent, such as sodium hydrosulfite, in order to prevent premature oxidation. Initially the bath is held at about 86° F. The temperature is then raised to 195° F and dyeing continued for one hour. Development takes place in a second bath with sodium bichromate, ammonium sulfocyanate, and sulfuric acid, first at 86° F, and then for one hour at 195° F. This process is rather similar to that used for dyeing silk, and gives beautiful, as well as deep shades on nylon, but the fastness to light is very poor in most cases, however.

FASTNESS TO LIGHT OF NORMAL DYEINGS

Table I gives the light fastness of a few Indigosol dyeings on nylon at 1%, made by the normal process.

TABLE I

Dyestuff	*Fastness to Light**
Indigosol Yellow GC	1
Indigosol Golden Yellow IGK	1
Indigosol Golden Yellow IRK	1
Indigosol Golden Orange I2R	2
Indigosol Brilliant Orange IRK	1
Indigosol Scarlet IB	3
Indigosol Pink IR extra	3-4
Indigosol Red Violet IRH	2
Indigosol Brown IRRD	2
Indigosol Grey IBL	2

*Fastness ratings are based on sunlight, not FOM exposures.

SUBSEQUENT TREATMENTS FOR IMPROVING LIGHT FASTNESS

STEAMING—According to an established process *(1)*, good light fastness on nylon can be obtained by drying the developed dyeings after the last rinsings and then steaming them under a pressure of about 2 atm. Whereas this steaming can usually be carried out in a printworks, it is seldom convenient in a dyehouse which does not always possess a steamer. Besides, steaming involves extra cost.

ETHYLENE GLYCOL——By another process *(2)* vat dyestuffs also can be made to give good fastness to light on nylon when the material, after development, is treated at the boil in a solution of 50-90% ethylene glycol at 212-222° F and afterwards cooled down in water within 5-15 seconds. This process, which must be repeated the necessary number of times required to improve the fastness, is rather difficult in practice. Moreover, it raises the cost of dyeing.

CERTAIN BENZENE DERIVATIVES——Another recent process *(3)*, described by Crosland & Pickstone, improves the light fastness of vat dyestuffs on nylon by treating developed dyeings in a solution of one or more benzene derivatives, including an OH and/or COOH group, such as phenols, cresols, salicylic acid, m- or p-oxy-benzoic acid, cinnamic acid, and phenylic propionic acid. The procedure is as follows:

Nylon is dyed with one or more vat dyestuffs in aqueous alkaline solutions in the presence of reducing agents. The goods are then rinsed in water and developed in a hot bath containing bichromate. Afterwards they are rinsed in water once again, soaped in a fresh bath, rinsed and dried. A subsequent treatment involving aqueous solutions of benzene derivatives containing an OH and/or a COOH group at high temperatures improves the fastness to light.

IMPROVING LIGHT FASTNESS WITHOUT SUBSEQUENT TREATMENT

It was observed in Durand & Huguenin's laboratories that very good light fastness was obtained with Indigosol dyeings on polyamide fibers when certain of the benzene derivatives used in the Crosland & Pickstone process—such as salicylic acid, cinnamic acid, etc—were added to the acid developing bath. Considerable economy of time and steam results. In some cases, the benzene derivatives previously mentioned may be added to the Indigosol dyebaths with good results.

SUITABLE DERIVATIVES——Not all the benzene derivatives having an OH and/or COOH group are suitable for addition to Indigosol developing baths. The cresols are not suitable because of their insolubility in water. Cinnamic acid is poorly soluble in water and only small quantities can be incorporated into the developing bath. The improvement in light fastness thus obtained is very little. More success is to be had with phenol at the rate of 30-40 g per liter, but the use of phenol is limited by its poisonous effects and its pungent smelling emanations. Oxybenzoic acid imparts a considerable improvement to the light fastness but only when used in large quantities. When employed in quantities of less than 50 g per liter, the improvement is insufficient.

We have ascertained that the weak organic salicylic acid is particularly efficient as an addition to Indigosol developing baths. Vat dyestuffs can also be developed with additions of salicylic acid and give, without subsequent treatment, dyeings having excellent fastness to light.

DEVELOPMENT OF INDIGOSOL DYEINGS——Generally, Indigosol dyeings on nylon are developed as follows:

The goods are treated for 10 minutes at 86° F in a bath containing

1% sodium bichromate
2% ammonium sulfocyanate

Then add

10 cc sulfuric acid 168° Tw

and develop for one hour at 195° F.

TABLE II

	Normal dyeings	*Dyeings developed with addition of 25 g salicylic acid per liter developing bath*
1% Indigosol Brilliant Orange IRK	1	6-7*
1% Indigosol Pink IR extra	3-4	7
1% Indigosol Red Violet IRH	2	6-7
1% Indigosol Brown IRRD	2	7
1% Indigosol Grey IBL	2	6

*Fastness ratings are based on sunlight, not FOM exposures.

To these normal developing baths add —preferably together with the sulfuric acid—25 g salicylic acid per liter. In many cases the addition of benzene derivatives such as salicylic acid involves a slight change of shade. An Indigosol dyeing developed in the presence of salicylic acid will be generally somewhat duller, and sometimes weaker, than one normally developed. Besides, the nylon fabrics generally shrink to a greater extent, in length and width, when developed with the addition of salicylic acid.

Certain Indigosols can be developed solely with a weak organic acid such as salicylic acid, which is then added at the rate of 50 g per liter, but the quantitites of sodium bichromate and ammonium sulfocyanate do not change. As previously mentioned, the salicylic acid may be added to the dyebath. In this case the improvement in the fastness is inferior to that obtained by adding the salicylic acid to the developing bath. Moreover, the salicylic acid retards the transfer of dyestuff to the fiber when employed in the dyebath, and its poor solubility under 195° F does not allow its employment in concentrations over 25 g per liter. Because of this, such a method is of little importance in practice.

FASTNESS TO LIGHT——Indigosol dyeings on nylon which have not undergone subsequent treatment and which have been developed without addition of salicylic acid, possess a light fastness of 1 to 3-4 as shown in Table I. Table II shows the difference resulting from the addition of salicylic acid to the developing bath.

DEVELOPMENT OF VAT DYEINGS ——As previously mentioned dyeings made on nylon with vat colors developed with addition of salicylic acid also possess a light fastness which is as good as that obtained by subsequent treatment of developed dyeings.

THEORY

In polyamide fibers dyed with Indigosols and vat dyestuffs by the normal process, the dyestuff seems to be present in the form of a fine dispersion. By submitting the developed dyeings to a subsequent treatment, for instance, steaming under pressure, a swelling of the fibers takes place and the dispersed vat dyestuff is probably aggregated. In the latter form it possesses a better light fastness than when in a fine dispersion. If the development of dyeings made with Indigosols and vat dyestuffs on nylon is carried out in the presence of benzene derivatives, for example, salicylic acid, it can be presumed that the vat dyestuff pigments are directly formed into aggregations in the interstices of the fibers enlarged by the swelling.

SUMMARY

Good light fastness for dyeings made with Indigosols and vat dyestuffs on nylon can be obtained in a very simple way by addition of certain benzene derivatives to the developing bath. For this purpose, salicylic acid, in quantities of 25 g per liter, is particularly suitable. By addition of salicylic acid to the developing bath, all subsequent treatments for improving light fastness, such as steaming under pressure, become unnecessary.

REFERENCES

1) Durand & Huguenin S A, British Patent 603,154, French Patent 908,609.
2) G T Douglas, DuPont, U S A Patent 2,541,839, *J Soc Dyers Colourists*, April '51, page 133.
3) Crosland & Pickstone, British Patent 632,083, French Patent 960,903.
4) Durand & Huguenin S A, "Dyeing with Indigosol Dyestuffs", 2nd edition, page 216.

NEWS

Participants in the textile testing methods forum, held in conjunction with the exhibition of textile testing equipment and the annual meeting of the Quebec Section, CATCC, included (l to r): E W Finlayson, director, Canadian Research Institute of Launderers and Cleaners; M L Staples, assistant director, textile department, Ontario Research Foundation; Grace Frank, professor of textile chemistry, University of Montreal; H K Torpey, then president of the Textile Technical Federation and forum moderator; Dr H W Stiegler, research director, American Association of Textile Chemists and Colorists; E J Tyrrell, director, research bureau, T Eaton Co Ltd, Toronto, Ont.

• Testing Equipment Exhibit and Forum Attract Over 700 in Canada

Over 700 visitors, technicians and mill executives from the U S and Canada were on hand in Montreal on April 25-26 to view the textile testing laboratory equipment of 26 firms and the educational projects of three Canadian textile schools and three non-Canadian technical associations, as well as to attend a testing forum featuring a select panel of speakers.

The exhibition and forum, first of its kind to be undertaken in Canada, was sponsored by (and run in conjunction with) the Canadian Association of Textile Colourists and Chemists, Quebec Section. Leon F Moody, Duplan Dyeing Co Ltd,

was exhibit chairman; E V Burnthall, Ciba Co Ltd, heads the CATCC Test Methods Committee.

Dr Harold W Stiegler, AATCC director of research, conveyed the congratulations of the American organization to the Quebec group for the success of the affair. He stated that it was heartening to see the exhibit and particularly gratifying to note the determination of Canadian textile technicians in meeting the challenges facing industry everywhere in testing and processing. Dr Stiegler and Edwin P Johnstone represented the AATCC at that organization's research exhibit. The Society of Dyers and Colourists and the Schweiz Verband Ferdie Material-Priefungen de Technik were also exhibitors. Representative Canadian organizations included the National Research Council, the Ontario Research Foundation and the Canadian Research Institute of Launderers and Cleaners.

New officers of the CATCC, elected at the annual meeting on the 26th, were as follows: *President*—S W Milnes; *Vice-Presidents*—Dr L J Sheps and Leon E Moody; *Secretary-Treasurer* — J Leight; *Council Members*—Dr C E Coke, K R J Horner, R W Redston, A Graborne, J Ramsden, E Sewell, E Bradley (Honorary President) and C Wills (Past President).

Quebec Members chosen as delegates to the National Council, CATCC, include: F J Knight, F B Wallace, and G C Taylor. Delegates to the Textile Technical Federation are: S W Milnes, Drs Sheps and Coke, and Leon E Moody.

• GAW Department Moves to N Y

The Product Development Department of General Aniline Works Division will be moved to 435 Hudson Street in New York from its present location in Easton, Pa, by June 1, according to an announcement by Dr J H Bruun, Director of Commercial Development of GAW.

Dr Bruun said the transfer is being made to achieve better co-ordination between the Product Development Department and other division departments headquartered in New York, including market research, sales and patents.

The Central Research Laboratory of the Division is not affected by the PDD-move, and will continue to be located in Easton.

• Connecticut Governor to Address DCAT

John Lodge, Governor of Connecticut, will be the guest speaker at the DCAT Spring Luncheon Meeting on Wednesday, June 11th, at the Hotel Astor, New York.

Emery Industries Chemical Sales Conference
Seated: Left to right, H D Armitage, W J Siemens, J P Clancy, W T Meinert, R T Hull, A R McDermott, L J Hadobas, R A Behrmann, V W Colby. 2nd Row: R F Brown, K K Boyd, J M Washburn, Jr, J P Kramer, R J Roberts, D R Eagleson, F L Ekstrand, N F Reinert, N J York, R M Geis. 3rd Row: O W B'Hymer, N A Ruston, W A Colby, J A Funk, T L Reilling, L F Church, L E Francis, J W Ritz, A C Fusaro.

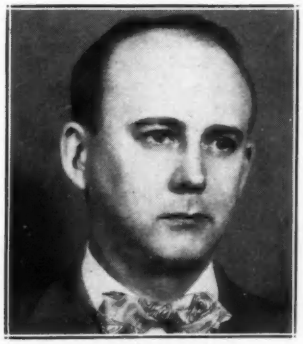
• Emery Program of Territorial Expansion

A program of territorial expansion now underway to insure better service to users of Emery fatty acids, Twitchell products, and plasticizers was one of the chief developments of the recent annual meeting of the Chemical Sales Staff of Emery Industries, Inc, in Cincinnati, O.

Under the program, A R McDermott, who comes from the Chicago district office, assumes responsibility for all sales in Texas, Louisiana, Oklahoma and Arkansas. N F Reinert, formerly with the Development and Service Department, is assigned to the Chicago office where he will work under D R Eagleson, who is in charge of that office.

A R McDermott

N F Reinert



F L Ekstrand

A new addition to Emory's sales staff, F L Ekstrand, is assigned to the Philadelphia office and will cover eastern Pennsylvania and South Jersey. Mr Ekstrand was formerly with Borne Scrymser Company.

The general theme of the sales meeting, "Better Service to Fatty Acid Users", was highlighted by an unusual panel discussion in which the individual salesmen exchanged information, ideas, and experiences pertaining to both successful and unsuccessful sales experiences and product applications. Each discussion was supplemented with samples of the products involved.

The meeting concluded with a golf tournament in which home-office executives competed unsuccessfully against sales personnel. J P Clancy reportedly walked off with the honors.

• 2nd Annual Textile Workshop

The Second Annual Textile Workshop, sponsored by the Lowell Textile Institute Research Foundation, will be held in Lowell, Mass, from June 16-July 25.

The Textile Workshop is a comprehensive course of study in the manufacturing, processing and evaluation of modern textiles and is intended for industrial research personnel.

Enrollment is limited to 26 active participants, with a maximum of four representatives from one organization.

Correspondence should be addressed to Prof Ernest P James, Director of Summer School, Lowell Textile Institute, Lowell, Mass.

• CSMA Meets June 9-10 in Boston

The 38th Midyear Meeting of the Chemical Specialties Manufacturers Association will be held June 9-10 at the Sheraton-Plaza Hotel, Boston, Mass, according to C L Weirich, C B Dolge Co, CSMA president.

T Carter Parkinson, McCormick & Co, will be in charge of the general program; William Flatow, Jr, West Disinfecting Co, will be in charge of entertainment.

More than 40 papers and addresses are slated at the six division meetings, as well as symposiums on technical aspects of products.

"World Market Conditions" will be presented by J L Brenn, Huntington Laboratories, who has just returned from a world-wide commercial trip. "Business in Government" will be covered by Francis L Curtis, Monsanto Chemical Co.

• Jones to Address Chemists and Tanners

Lauren L Jones, president of the Tanners' Council of America, will address members and guests of the American Leather Chemists Association Convention at its banquet on Tuesday evening, June 3. His address will highlight a four-day program from June 1-4 at the New Ocean House, Swampscott, Mass.

The following committee meetings will be held on June 1: Vegetable Leather (Tan Analysis), Mineral Leathers, Physical Testing, Leather Finishes, Preparatory Tanning Operations, Tannery Practice (Industrial Waste Disposal), and Standards and Specifications.

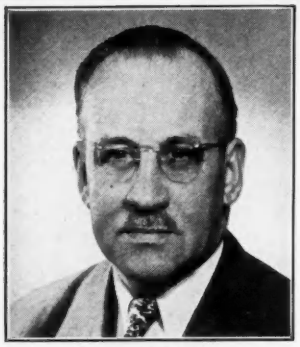
Seventeen technical papers will be featured during the following three days, in addition to the regular business meeting and meeting of the technical committee board on June 2.

Tuesday afternoon (June 3) will feature a golf tournament and a visit to the United Shoe Machinery Corp plant and laboratories.

• ACCCE to Hold Outing June 6

The Association of Consulting Chemists and Chemical Engineers, Inc, will hold its annual Spring Outing on Friday, June 6, at the Westchester Country Club, Rye, N Y, beginning 1:00 PM and lasting through the evening. Golf and Tennis will be part of the afternoon entertainment, and card games will be played after dinner, which is scheduled for 6:30 PM.

NAMES IN THE NEWS



George O Linberg

GEORGE O LINBERG has been elected vice president and New England sales manager of Synthron, Inc of Ashton, R I, as of May 1, according to an announcement by Robert Zametkin, treasurer.

Mr Linberg was formerly vice president of Belle Chemical Co. Prior to his association with Belle, he had been sales manager and assistant to the director of the Textile Department of Monsanto Chemical Company, and previously was with the Organic Chemicals Dept of E I du Pont de Nemours & Co, Inc.

A former vice president of the AATCC, Mr Linberg is currently serving as Chairman of that organization's forthcoming 1952 Convention in Boston. He was most recently elected president of the Drysalters Club of New England.

KENNETH C EVERETT, formerly with Powdrell and Alexander, Inc, has become research and development chemist for Kenyon Piece Dye Works Inc, Kenyon, R I.

S H Williams

S H WILLIAMS has been elected a vice president of the General Dyestuff Corporation and also becomes general sales manager for the Company, according to an announcement on May 12th by John C Franklin, executive vice president.

Mr Williams, for the past ten years manager of the Charlotte (N C) office for GDC, will make his headquarters in New York.

Succeeding Mr Williams as Charlotte manager is C C CAYCE, formerly assistant manager.

The appointment of ARMAND WALDMAN as assistant director of products development for the Warwick Chemical Company, Division of Sun Chemical Corporation, was recently announced by D J Eccleston, general manager. In his new capacity, Mr Waldman will be directly associated with Donald D Gagliardi, director of products development.

OBITUARY

P Van Vlaanderen

PETER VAN VLAANDEREN

PETER VAN VLAANDEREN, 78, founder of the Van Vlaanderen Machine Company, Paterson, N J, died suddenly April 21st at St Luke's Hospital, New York, N Y.

Under his direction the Paterson concern became an acknowledged leader in the field of broad goods dyeing and finishing machinery. He resigned as president in 1942.

Surviving Mr Van Vlaanderen are his widow and two sons, Cornelius and George.

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